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FINAL

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN

SITES 41, 69 AND 74 (OPERABLE UNIT NO. 4)

MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0106

Prepared For:

DEPARTMENT OF THE NAVY
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NAVAL FACILITIES
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AMTRAC	Amphibious Tractor Battalion
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
Baker	Baker Environmental, Inc.
bgs	below ground surface
BHC,D	lindane or hexachlorocyclohexane
bls	below land surface
BOD	biological oxygen demand
BRA	baseline risk assessment
BTEX	benzene, toluene, ethylbenzene, xylene
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLEJ	Camp Lejeune
CLP	Contract Laboratory Program
CN	chloroacetophenone
COD	chemical oxygen demand
COPC	contaminants of potential concern
CRQL	contract required quantitation limit
CSM	chemical surety compound
°F	degrees Fahrenheit
DEHNR	Department of Environment, Health and Natural Resources
1,2-DCE	1,2-dichloroethene or 1,2-dichloroethylene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DOD	Department of the Defense
DoN	U. S. Department of the Navy
DQO	Data Quality Objectives
EDI	estimated daily intake or exposure
EM	electromagnetic
EMD	Environmental Management Division (Camp Lejeune)
EPA	United States Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center
ER-L	Effective Range-Low
ESE	Environmental Science and Engineering, Inc.
exp	expotential
FFA	Federal Facilities Agreement
FMFLANT	Fleet Marine Force Atlantic
FSAP	Field Sampling and Analysis Plan
ft	feet
ft/ft	foot per foot
FY94 SMP	Fiscal Year 1994 Site Management Plan
GAC	granular activated carbon

gpm	gallons per minute
GRI	Gas Research Industry
GSRA	Greater Sandy Run Area
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HPIA	Hadnot Point Industrial Area
HQ	hazard quotient
HTH	high test hypochlorite
IAS	Initial Assessment Study
IDL	instrument detection limit
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
MAGTF	Marine Air Ground Task Force
MEK	methyl ethyl ketone
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
MDL	method detection limit
mg/L	milligrams per liter
MIBK	methyl isobutyl ketone
MS	matrix spike
MSD	matrix spike duplicate
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
NC	North Carolina
N.C. DEHNR	North Carolina Department of Environment, Health, and Natural Resources
NCP	National Contingency Plan
NCWQS	North Carolina Water Quality Standards
ND	nondetect
NEESA	Naval Energy and Environmental Support Activity
NH_4	ammonia nitrogen
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NREA	Natural Resources and Environmental Affairs
OCP	organochloride pesticides
O&M	operation and maintenance
PAH	polynuclear aromatic hydrocarbon
PC	personal computer
PCB	polychlorinated biphenyls
POL	petroleum, oils, and lubricants
POTW	publicly owned treatment work
ppb	parts per billion
ppm	parts per million
PRAP	Proposed Remedial Action Plan
PVC	polyvinylchloride

QA/QC	quality assurance/quality control
RA	risk assessment
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RDX	cyclotrimethylenetrinitramine
2nd FSSG	2nd Force Service Support Group
SARA	Superfund Amendments and Reauthorization Act
SMCL	Secondary Maximum Contaminant Level
SQL	sample quantitation
STOLS	surface towed ordnance locator system
STP	sewage treatment plant
TAL	Target Analyte List
TBC	to be considered
TCDD	tetrachlorodioxin
TCE	trichloroethylene or trichloroethene
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TEU	U.S. Army Technical Escort Unit
TNT	trinitrotoluene
TOC	total organic carbon
TRC	Technical Review Committee
UCL	upper confidence limit
µg/kg	microgram per kilogram
µg/g	micrograms per gram
µg/L	micrograms per liter
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
UV	ultraviolet
UXO	unexploded ordnance
VOC	volatile organic compound

1.0 INTRODUCTION

Marine Corps Base (MCB) Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) National Priorities List (NPL) effective November 4, 1989 (54 Federal Register 41015, October 4, 1989). Subsequent to this listing, the United States Environmental Protection Agency (USEPA) Region IV, the North Carolina Department of Environment, Health and Natural Resources (DEHNR), and the United States Department of the Navy (DoN) entered into a Federal Facilities Agreement (FFA) for MCB Camp Lejeune. The primary purpose of the FFA was to ensure that environmental impacts associated with past and present activities at the MCB are thoroughly investigated, and that appropriate CERCLA response/RCRA corrective action alternatives are developed and implemented as necessary to protect the public health and welfare, and the environment (MCB Camp Lejeune FFA, 1989).

The scope of the FFA included the implementation of a remedial investigation/feasibility study (RI/FS) at 27 sites across MCB Camp Lejeune. RIs will be implemented at these sites to determine fully the nature and extent of the threat to the public health and welfare, or to the environment caused by the release and threatened release of hazardous substances, pollutants, contaminants or constituents at the site and to establish requirements for the performance of FSs. Feasibility studies will be conducted to identify, evaluate, and select alternatives for the appropriate CERCLA responses to prevent, mitigate, or abate the release or threatened release of hazardous substances, pollutants, contaminants, or constituents at the site in accordance with CERCLA/Superfund Amendments and Reauthorization Act of 1986 (SARA) and applicable State law (FFA, 1989).

This RI/FS Work Plan addresses 3 of the 27 sites: Site 69 (Rifle Range Chemical Dump); Site 74 (Mess Hall Grease Pit Disposal Area); and Site 41 (Camp Geiger Dump Near Former Trailer Park). These sites have similar characteristics in that chemical surety materiels may be present. The three sites have been grouped into Operable Unit No. 4 for purposes of this RI/FS. There are 13 operable units in various stages of investigation at MCB Camp Lejeune.

1.1 Objective of RI/FS Work Plan

The objective of this RI/FS Work Plan is to identify the tasks required to implement an RI/FS for Sites 69, 74, and 41 at MCB Camp Lejeune. The various studies or investigations required to collect appropriate data are described in this Work Plan. In addition, the Work Plan

documents the scope and objectives of the individual RI/FS activities. It serves as a tool for assigning responsibilities and establishing the project schedule and cost. The preparation and contents of the RI/FS Work Plan are based on the scoping process, which is described below.

1.2 RI/FS Scoping

Scoping is the initial planning stage of the RI/FS and of site remediation. The result or outcome of the scoping process is documented in the RI/FS Work Plan. Scoping begins once the background information is reviewed and evaluated and consists of the following activities:

- Assessing human health and environmental risks.
- Identifying actions to mitigate potential threats to the public health and the environment.
- Identifying potential contaminant migration pathways.
- Identifying contaminants of concern.
- Identifying Federal and State Applicable or Relevant and Appropriate Requirements (ARARs).
- Identifying potential technologies/alternatives for mitigating site problems.
- Determining the type, amount, and data quality objectives (DQOs) to assess human health and environmental risks, and to effectively evaluate feasible technologies/alternatives.
- Identifying the remedial alternatives suitable to site conditions.

The background information available to this process included a number of existing environmental assessment reports, which are identified in Section 8.0 (References), and information collected during planning visits at each site. In addition, one round of groundwater samples was collected in 1992 at Site 74 to evaluate "current" groundwater characteristics. Geophysical investigations were also conducted in 1992 at Sites 69 and 74 in order to identify potential disposal area. A copy of the geophysical report is provided in Appendix A.

As part of the scoping process, project meetings were conducted with the Atlantic Division, Naval Facilities Engineering Command (LANTDIV), USEPA Region IV, and the North Carolina DEHNR to discuss the proposed RI/FS scope of work for each site, and to obtain technical and administrative input from LANTDIV.

2.0 BACKGROUND AND SETTING

The purpose of this section is to summarize and evaluate existing information pertaining to MCB Camp Lejeune, Sites 69, 74, and 41. The analysis of existing information will serve to provide an understanding of the nature and extent of contamination in order to aid in the design of RI tasks. The current understanding of the physical setting of the sites, the history of the sites, and the existing information related to previous environmental investigative activities are described herein.

This section specifically addresses the location and setting of the sites, historical events associated with past usage or disposal activities, topography and surface drainage, regional geology and hydrogeology, site-specific geology and hydrogeology, surface water hydrology, climatology, natural resources and ecological features, and land use.

Additional information can be found in the following documents:

- Initial Assessment Study (IAS) of Marine Corps Base Camp Lejeune, North Carolina (Water and Air Research, 1983)

- Final Site Assessment Report for Sites 6, 48, and 69, Characterization Study to Determine Existence and Possible Migration of Specific Chemicals In Situ, (Environmental Science and Engineering, Inc., 1992)

- Final Site Summary Report, Marine Corps Base, Camp Lejeune (Environmental Science and Engineering, Inc. 1990)

- Hydrogeology of Aquifers in Cretaceous and Younger Rocks in the Vicinity of Onslow and Southern Jones Counties, North Carolina (U.S. Geological Survey, 1990)

- Continuous Seismic Reflection Profiling of Hydrogeologic Features Beneath New River, Camp Lejeune, North Carolina (U.S. Geological Survey, 1990)

- Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina (U.S. Geological Survey, 1989)

2.1 Marine Corps Base, Camp Lejeune

This section provides an overview of the physical features associated with MCB Camp Lejeune, North Carolina.

2.1.1 Location and Setting

MCB Camp Lejeune is located within the Coastal Plain Physiographic Province in Onslow County, North Carolina, approximately 45 miles south of New Bern and 47 miles north of Wilmington. The facility covers approximately 236 square miles. This includes the recent acquisition of approximately 64 square miles west of the facility within the Greater Sandy Run Area of the county. The military reservation is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean.

The eastern border of MCB Camp Lejeune is the Atlantic shoreline. The western and northwestern boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders MCB Camp Lejeune to the north. MCB Camp Lejeune is depicted in Figure 2-1.

The Greater Sandy Run Area (GSRA) is located in the southeast portion of Onslow County, North Carolina, near the Pender-Onslow County border. The GSRA is approximately 31 miles northeast of Wilmington, North Carolina; 15 miles south of Jacksonville, North Carolina; and 5 miles northwest of the Atlantic Ocean. The GSRA is located south and west of MCB, Camp Lejeune, sharing a common boundary along Route 17 between Dixon and Verona.

The following overview of the Complex was taken from the document "Master Plan, Camp Lejeune Complex, North Carolina." The Complex consists of 12 identifiable developed areas. Of the developed areas, Hadnot Point comprises the most concentrated area of development. This area includes the organizational offices for the Host Activity and for the Headquarters, 26 Marine Amphibious Unit, as well as the Headquarters and regimental areas for the 2nd Division of the Marine Crops, 2nd Marine Amphibious Force, 6th Marine Amphibious Brigade, 22nd Marine Amphibious Unit, 24th Marine Amphibious Unit, the Central Exchange & Commissary and the Naval Dental Clinic Headquarters. Directly north of Hadnot Point are the family housing areas concentrated throughout the wooded areas of the central Complex and along the shores of the New River. Also located in this north central area are major personnel support land uses, including the newly-constructed Naval Hospital,

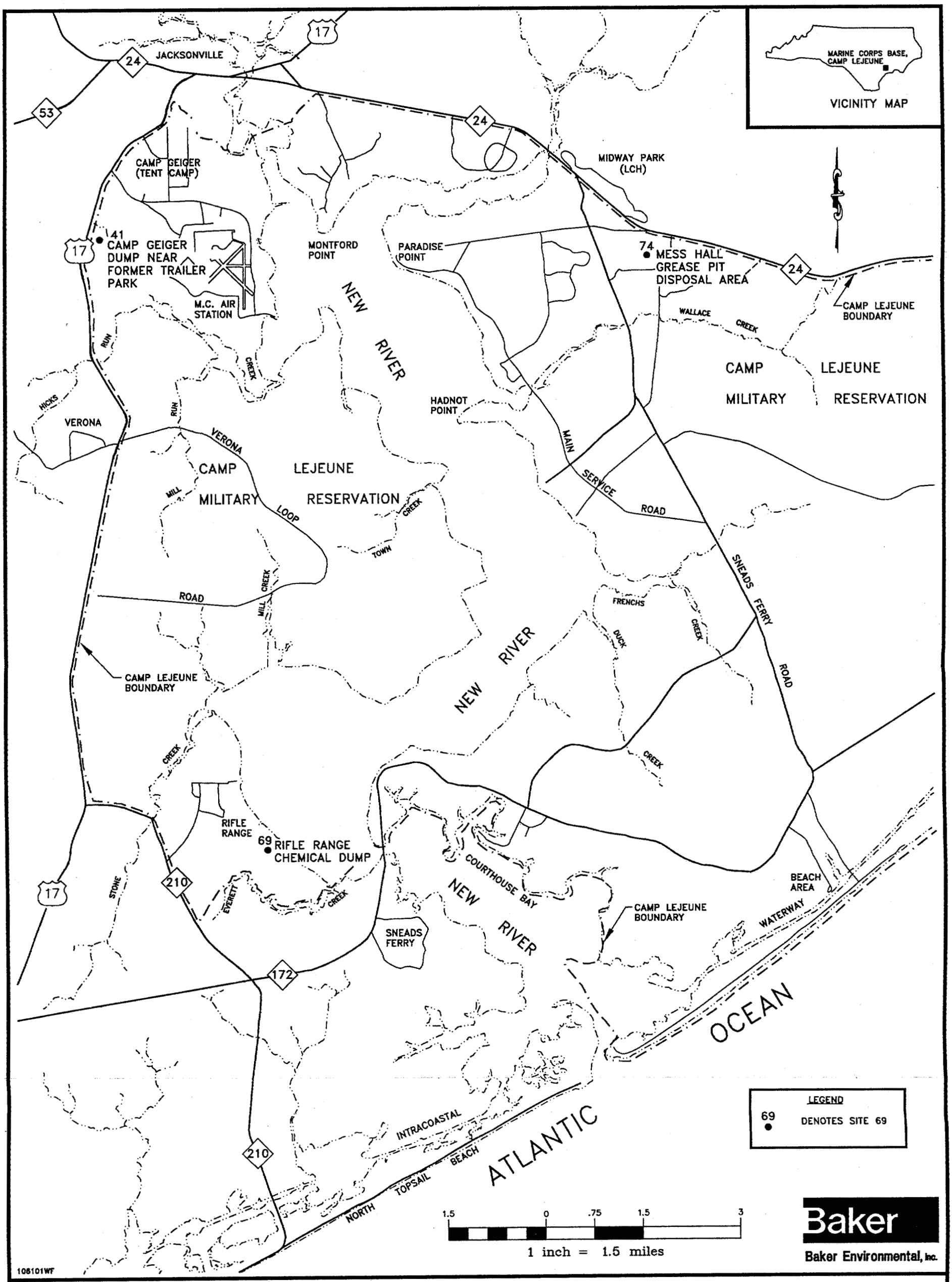

FIGURE 2-1
MCB CAMP LEJEUNE
LOCATION MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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school sites, recreational areas, as well as additional family housing areas (quarters developments, Midway Park and Tarawa Terrace I and II).

The Air Station and Camp Geiger are considered as a single urban area possessing two separate missions and supported by two unrelated groups of personnel. The Marine Corps Air Station (MCAS), New River encompasses 2,772 acres and is located in the northwestern section of the Complex and lies approximately five miles south of Jacksonville. The MCAS includes air support activities, troop housing and personnel support facilities, all of which immediately surround the aircraft operations and maintenance areas.

Camp Geiger, located directly north of MCAS, New River, contains a mixture of troop housing, personnel support and training uses. Currently, the area is utilized by a number of groups which have no direct relationship to one another. The majority of the land surrounding this area is comprised of buffer zones and unbuildable marshland.

The Camp Lejeune Complex contains five other areas of concentrated development, all of which are much smaller in size and population than either Hadnot Point, MCAS New River, or the Camp Geiger area. The oldest of these is the Montford Point area, which is bounded by the New River to the south and west and by Route 24 on the north. New development in Montford Point has been limited, with most of the facilities for troop housing, maintenance, supply and personnel support having been converted from their intended uses. A majority of the MCB training schools requiring classroom instruction are located here and use surrounding undeveloped areas for training operations when required. The French Creek area located directly south of Hadnot Point is occupied by the 2nd Force Service Support Group (2nd FSSG). Its activities are directed toward providing combat service and technical support as required by Headquarters, II Marine Amphibious Force. Expansion of the French Creek Complex is constrained by the Ordnance Storage Depot explosives safety arc on the south and by the regimental area of Hadnot Point. Onslow Beach, located along the Onslow Bay, east of the New River Inlet, presents assets for amphibious training as well as recreational use. Courthouse Bay is located on one of a series of small bays which are formed by the New River. This area is used for maintenance, storage and training associated with amphibious vehicles and heavy engineering equipment. The Engineering School, also located here, conducts training activities in the large open area located to the southeast of the Courthouse Bay. Another concentrated area of development is the Rifle Range. This area is located on the southwest side of the New River, is singular in purpose and has only a small number of assigned personnel. It was constructed in the early stages of Base development and is used

solely for rifle qualification training. The small group of barracks, located at the Rifle Range, are used for two-week periods by troops assigned to range training.

2.1.2 History and Mission

Construction of MCB Camp Lejeune began in 1941 with the objective of developing the "Worlds Most Complex Amphibious Training Base." Construction of the base started at Hadnot Point, where the major functions of the base are centered. Development at the Camp Lejeune Complex is primarily in five geographical locations under the jurisdiction of the Base Command. These areas include Camp Geiger, Montford Point, Courthouse Bay, Mainside, and the Rifle Range Area. Site 69 is located in the Rifle Range Area; Site 74 is located on Mainside; and Site 41 is located in the Camp Geiger Area (Water and Air Research, 1983).

The MCB organization functions as the host command to the two Fleet Marine Force Atlantic (FMFLANT) tenant activities -- Headquarters of the II Marine Amphibious Division and the 2nd FSSG. The MCB host organization mission is to provide housing, training facilities, logistical support and certain administrative support for tenant units and for other units assigned to MCB Camp Lejeune and to conduct specialized schools and other training maneuvers, as directed.

The mission of the 6th Marine Amphibious Brigade is to provide the Command element for a brigade-size Marine Air Ground Task Force (MAGTF) with the primary mission of preparing to join up with LantCom MPS equipment and to conduct subsequent combat operations.

The mission of the 2nd Marine Division is to execute amphibious assault operations, and other operations as may be directed, which are supported by Marine aviation and force service support units. With the aircraft wing, the Marine division provides combined arms for service with the Fleet in the seizure or defense of advanced naval bases and for the conduct of land operations essential to the prosecution of a naval campaign.

The mission of the 2nd FSSG is to command, administer and train assigned units in order to provide combat service and technical support as required by Headquarters FMFLANT and its subordinate command in accomplishment of the overall FMFLANT mission.

2.1.3 Topography and Surface Drainage

The generally flat topography of MCB Camp Lejeune is typical of the seaward portions of the North Carolina Coastal Plain. Elevations on the base vary from sea level to 72 feet above mean sea level (msl); however, the elevation of most of MCB Camp Lejeune is between 20 and 40 feet above msl.

Drainage at MCB Camp Lejeune is generally toward the New River, except in areas near the coast, which drain through the Intracoastal Waterway. In developed areas, natural drainage has been altered by asphalt cover, storm sewers, and drainage ditches. Approximately 70 percent of MCB Camp Lejeune is in broad, flat interstream areas. Drainage is poor in these areas (Water and Air Research, 1983).

The U.S. Army Corps of Engineers has mapped the limits of 100-year floodplain at MCB Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (Water and Air Research, 1983); this increases downstream to 11 feet above msl near the coastal area (Water and Air Research, 1983). Neither Site 41, 69 nor 74 lie within the 100-year floodplain.

2.1.4 Regional Geology

MCB Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Atlantic Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments lay in interfingering beds and lenses that gently dip and thicken to the southeast (ESE, 1991). These sediments were deposited in marine or near-marine environments and range in age from early Cretaceous to Quaternary time and overlie igneous and metamorphic basement rocks of pre-Cretaceous age. Figure 2-2 presents a generalized stratigraphic column for this area (ESE, 1991).

United States Geological Survey (USGS) studies at MCB Camp Lejeune indicate that the Base is underlain by seven sand and limestone aquifers separated by confining units of silt and clay. These include the water table (i.e., surficial, water-bearing layer), Castle Hayne, Beaufort, Peedee, Black Creek, and upper and lower Cape Fear aquifers. The combined thickness of these sediments is approximately 1,500 feet. Less permeable clay and silt beds function as confining units or semiconfining units which separate the aquifers and impede the flow of groundwater between aquifers. A generalized hydrogeologic cross-section illustrating the relationship between the aquifers in this area is presented in Figure 2-3.

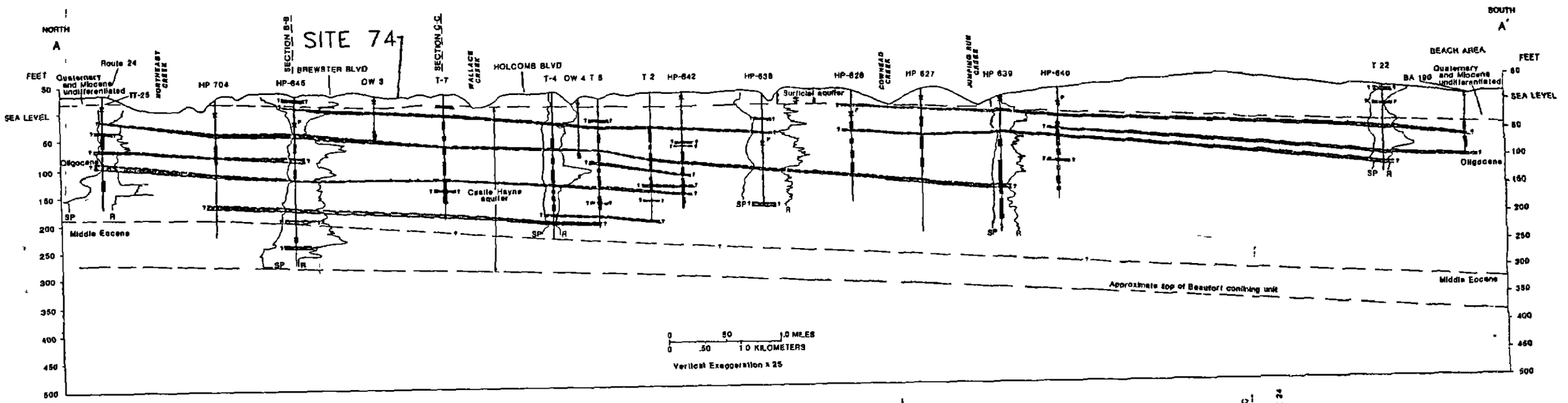
FIGURE 2-2

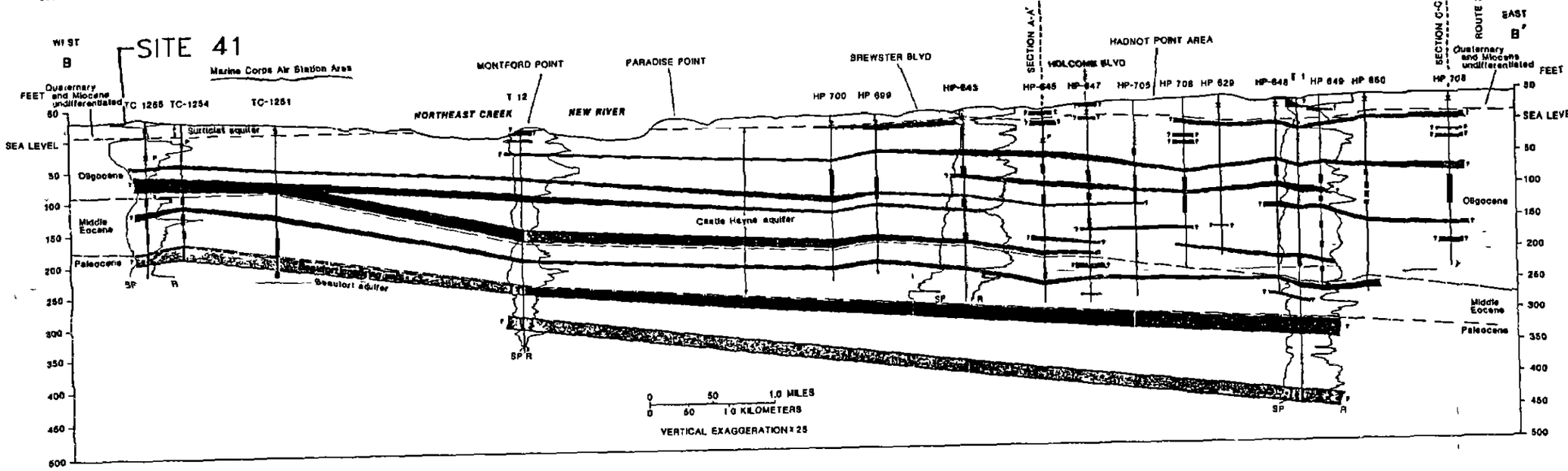
GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE COASTAL PLAIN OF NORTH CAROLINA

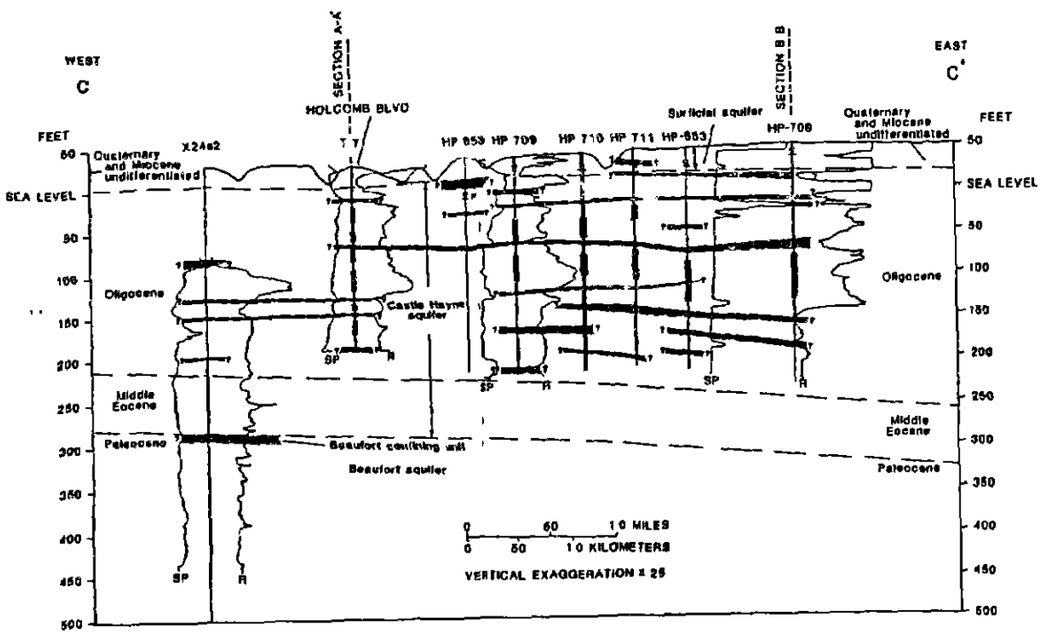
GEOLOGIC UNITS			HYDROGEOLOGIC UNITS
System	Series	Formation	Aquifer and Confining Unit
Quaternary	Holocene/Pleistocene	Undifferentiated	Surficial aquifer
Tertiary	Pliocene	Yorktown Formation(1)	Yorktown confining unit Yorktown aquifer
	Miocene	Eastover Formation(1)	Pungo River confining unit
		Pungo River Formation(1)	Pungo River aquifer
		Belgrade Formation(2)	Castle Hayne confining unit
	Oligocene	River Bend Formation	Castle Hayne aquifer
	Eocene	Castle Hayne Formation	Beaufort confining unit(3)
	Paleocene	Beaufort Formation	Beaufort aquifer
Cretaceous	Upper Cretaceous	Peedee Formation	Peedee confining unit Peedee aquifer
		Black Creek and Middendorf Formations	Black Creek confining unit Black Creek aquifer
		Cape Fear Formation	Upper Cape Fear confining unit Upper Cape Fear aquifer Lower Cape Fear confining unit Lower Cape Fear aquifer
	Lower Cretaceous(1)	Unnamed deposits(1)	Lower Cretaceous confining unit Lower Cretaceous aquifer(1)
Pre-Cretaceous basement rocks		--	--

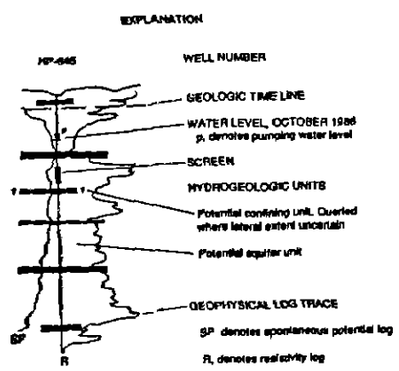
(1) Geologic and hydrologic units probably not present beneath Camp Lejeune.
(2) Constitutes part of the surficial aquifer and Castle Hayne confining unit in the study area.
(3) Estimated to be confined to deposits of Paleocene age in the study area.

Source: Harned et al., 1989.









HYDROGEOLOGIC SECTIONS LOCATED ON PLATE 4

FIGURE 2-3
HYDROGEOLOGIC CROSS-SECTIONS OF MCB CAMP LEJEUNE AREA
CTO-0106
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

023,7502X

HYDROGEOLOGIC SECTIONS A-A, B-B, AND C-C AT CAMP LEJEUNE, NORTH CAROLINA

2.1.5 Regional Hydrogeology

The following summary of regional hydrogeology was originally presented in Harned et al. (1989).

The surficial water-bearing layer (i.e., surficial aquifer) is a water table in a series of sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet. This unit is not used for water supply on the Base.

The principal water-supply aquifer for the Base is found in the series of sand and limestone beds that occur between 50 and 300 feet below land surface. This series of sediments generally is known as the Castle Hayne Formation, associated with the Castle Hayne Aquifer. This aquifer is about 150 to 350 feet thick in the area and is the most productive aquifer in North Carolina.

Clay layers occur in both of the aquifers. However, the layers are thin and discontinuous in most of the area, and no continuous clay layer separates the surficial aquifer from the Castle Hayne aquifer. The clay layers range from 5 to 30 feet thick and comprise between 15 and 24 percent of the combined thickness of the two aquifers. The clay layers appear to be thicker and more continuous in the northwestern part of the Base, particularly in the area of the MCAS. It is inferred from their generally thin and discontinuous nature that considerable leakage of groundwater occurs across and around the clay layers, particularly in the upper part of the Castle Hayne aquifer.

Onslow County and MCB Camp Lejeune lie in an area where the Castle Hayne Aquifer contains freshwater, although the proximity of saltwater in deeper layers just below the aquifer and in the New River estuary is of concern in managing water withdrawals. Overpumping of the deeper parts of the aquifer could cause encroachment of saltwater. The aquifer contains water having less than 250 milligrams per liter (mg/L) chloride throughout the area of the Base.

The aquifers that lie below the Castle Hayne lie in a thick sequence of sand and clay. Although some of these aquifers are used for water supply elsewhere in the Coastal Plain, they contain saltwater in the MCB Camp Lejeune area and are not used.

Rainfall in the MCB Camp Lejeune area enters the ground in recharge areas, infiltrates the soil, and moves downward until it reaches the water table, which is the top of the saturated zone. In the saturated zone, groundwater flows in the direction of lower hydraulic head, moving through the system to discharge areas like the New River and its tributaries, or the ocean.

The water table varies seasonally. The water table receives more recharge in the winter than in the summer when much of the water evaporates or is transpired by plants before it can reach the water table. Therefore, the water table generally is highest in the winter months and lowest in summer or early fall.

In confined aquifers, water is under excess hydraulic (i.e., head) pressure and the level to which it rises in a tightly cased well is called the potentiometric surface. The hydraulic head in a confined or semiconfined aquifer, such as the Castle Hayne, shows a different pattern of variation over time than that in an unconfined aquifer. Some seasonal variation also is common in the water levels of the Castle Hayne Aquifer, but the changes tend to be slower and over a smaller range than for water table wells.

2.1.6 Surface Water Hydrology

The following summary of surface water hydrology was originally presented in the IAS report (Water and Air Research, Inc., 1983).

The dominant surface water feature at MCB Camp Lejeune is the New River. It receives drainage from most of the base. The New River is short, with a course of approximately 50 miles on the central Coastal Plain of North Carolina. Over most of its course, the New River is confined to a relatively narrow channel entrenched in Eocene and Oligocene limestones. South of Jacksonville, the river widens dramatically as it flows across less resistant sands, clays, and marls. At MCB Camp Lejeune, the New River flows in a southerly direction into the Atlantic Ocean through the New River Inlet. Several small coastal creeks drain the area of MCB Camp Lejeune not associated with the New River and its tributaries. These creeks flow into the Intracoastal Waterway, which is connected to the Atlantic Ocean by Bear Inlet, Brown's Inlet, and the New River Inlet (Water and Air Research, 1983). The New River, the Intracoastal Waterway, and the Atlantic Ocean meet the New River Inlet.

Water quality criteria for surface waters in North Carolina have been published under Title 15 of the North Carolina Administrative Code. At MCB Camp Lejeune, the New River falls into two classifications: SC (estuarine waters not suited for body-contact sports or commercial shellfishing) and SA (estuarine waters suited for commercial shellfishing). The SC classification applies to three areas of the New River at MCB Camp Lejeune, including the Rifle Range area; the rest of the New River at MCB Camp Lejeune falls into the SA classification (ESE, 1991).

2.1.7 Climatology

MCB Camp Lejeune experiences mild winters and hot and humid summers. The average yearly rainfall is greater than 50 inches, and the potential evapotranspiration in the region varies from 34 to 36 inches of rainfall equivalent per year. The winter and summer seasons usually receive the most precipitation. Temperature ranges are reported to be 33 to 53 degrees Fahrenheit (°F) in the winter (i.e., January) and 71 to 88°F in the summer (i.e., July). Winds are generally south-southwesterly in the summer, and north-northwesterly in the winter (Water and Air Research, 1983).

2.1.8 Natural Resources and Ecological Features

The following summary of natural resources and ecological features was obtained from the IAS Report (Water and Air Research, 1983).

The Camp Lejeune Complex is predominantly tree-covered with large amounts of softwood including shortleaf, longleaf, pond, and pines, primarily loblolly, and substantial stands of hardwood species. Approximately 60,000 of the 112,000 acres of MCB Camp Lejeune are under forestry management. Timber producing areas are under even-aged management with the exception of those areas along streams and swamps. These areas are managed to provide both wildlife habitat and erosion control. Forest management provides wood production, increased wildlife populations, enhancement of natural beauty, soil protection, prevention of stream pollution, and protection of endangered species.

Upland game species including black bear, whitetail deer, gray squirrel, fox squirrel, quail, turkey, and migratory waterfowl are abundant and are considered in the wildlife management programs.

Aquatic ecosystems on MCB Camp Lejeune consist of small lakes, the New River estuary, numerous tributaries, creeks, and part of the Intracoastal Waterway. A wide variety of freshwater and saltwater fish species exist here. Freshwater ponds are under management to produce optimum yields and ensure continued harvest of desirable fish species (Water and Air Research, 1983). Freshwater fish in the streams and ponds include largemouth bass, redbreast sunfish, bluegill, chain pickerel, yellow perch, and catfish. Reptiles include alligators, turtles, and snakes, including venomous. Both recreational and commercial fishing are practiced in the waterways of the New River and its tributaries.

Wetland ecosystems at MCB Camp Lejeune can be categorized into five habitat types: (1) pond pine or pocosin; (2) sweet gum, water oak, cypress, and tupelo; (3) sweet bay, swamp black gum, and red maple; (4) tidal marshes; and, (5) coastal beaches. Pocosins provide excellent habitat for bear and deer because these areas are seldom disturbed by humans. The presence of pocosin-type habitat at MCB Camp Lejeune is primarily responsible for the continued existence of black bear in the area. Many of the pocosins are overgrown with brush and pine species that would not be profitable to harvest. Sweet gum, water oak, cypress, and tupelo habitat is found in the rich, moist bottomlands along streams and rivers. This habitat extends to the marine shorelines. Deer, bear, turkey, and waterfowl are commonly found in this type of habitat. Sweet bay, swamp black gum, and red maple habitat exist in the floodplain areas of MCB Camp Lejeune. Fauna including waterfowl, mink, otter, raccoon, deer, bear, and gray squirrel frequent this habitat. The tidal marsh at the mouth of the New River is one of the few remaining North Carolina coastal areas relatively free from filling or other manmade changes. This habitat, which consists of marsh and aquatic plants such as algae, cattails, saltgrass, cordgrass, bulrush, and spikerush, provides wildlife with food and cover. Migratory waterfowl, alligators, raccoons, and river otter exist in this habitat. Coastal beaches along the Intracoastal Waterway and along the outer banks of MCB Camp Lejeune are used for recreation and to house a small military command unit. Basic assault training maneuvers are also conducted along these beaches. Training regulations presently restrict activities that would impact ecologically sensitive coastal barrier dunes. The coastal beaches provides habitat for many shorebirds (Water and Air Research, 1983).

The Natural Resources and Environmental Affairs (NREA) Division of MCB Camp Lejeune, the U.S. Fish and Wildlife Service, and the North Carolina Wildlife Resource Commission have entered into an agreement for the protection of endangered and threatened species that might inhabit MCB Camp Lejeune. Habitats are maintained at MCB Camp Lejeune for the preservation and protection of rare and endangered species through the Base's forest and

wildlife management programs. Full protection is provided to such species, and critical habitat is designated in management plans to prevent or mitigate adverse effects of Base activities. Special emphasis is placed on habitat and sightings of alligators, osprey, bald eagles, cougars, dusky seaside sparrows, and red-cockaded woodpeckers (Water and Air Research, 1983).

None of the three sites under investigation are within or in close proximity (i.e., one-half mile) to either a natural area or a protected area. Protected areas have only been established for the red-cockaded woodpecker.

Within 15 miles of MCB Camp Lejeune are three publicly owned forests: Croatan National Forest; Hofmann Forest; and Camp Davis Forest. The remaining land surrounding MCB Camp Lejeune is primarily used for agriculture. Typical crops include soybeans, small grains, and tobacco (Water and Air Research, 1983).

2.1.9 Land Use and Demographics

The following information was extracted from the document "Master Plan, Camp Lejeune Complex, North Carolina." The existing land use patterns in the various geographic areas within the Marine Corps Base are described in this section and listed, per geographic area, on Table 2-1. The areas described below are depicted on Figure 2-1. In addition, the number of acres comprising each land use category has been estimated and provided on the table.

2.1.9.1 Hadnot Point

The development which typifies this area evolved over a 40-year period and includes approximately 1,080 acres of land. The land uses tend to be integrated with one another, creating an environment which is pedestrian in scale. Community and recreational land uses are scattered throughout the regimental area which covers about 18 percent (i.e., 196 acres) of all the developed land in Hadnot Point.

Administrative uses are situated in prominent central locations along the main entrance route, making them easily accessible to visitors and regimental personnel alike.

Segregated from the administrative personnel support and troop housing uses are supply/storage and maintenance uses which are consolidated in the eastern portion of Hadnot

TABLE 2-1

LAND UTILIZATION: DEVELOPED AREAS ACRES/LAND USE (PERCENT)
MCB, CAMP LEJEUNE, NORTH CAROLINA

Geographic Area	Oper.	Training (Instruc.)	Maint.	Supply/ Storage	Medical	Admin.	Family Housing	Troop Housing	CM	CO	Recreat.	Utility	Total
Hadnot Point	31 (2.9)	15 (1.4)	154 (14.3)	157 (14.4)	10 (0.9)	122 (11.3)	22 (2.0)	196 (18.1)	115 (10.7)	36 (3.3)	182 (16.9)	40 (3.7)	1,080 (100)
Paradise Point	1 (0)		3 (0.4)	1 (0)			343 (34)	19 (1.9)	31 (3.1)		610 (60.4)	2 (0.2)	1,010 (100)
Berkeley Manor/ Watkins Village							406 (80)		41 (8.1)	1 (0.2)	57 (11.2)	2 (0.5)	507 (100)
Midway Park		1 (0.4)		2 (0.7)		2 (0.7)	248 (92.2)		8 (3.0)	3 (1.1)	4 (1.5)	1 (0.4)	269 (100)
Tarawa Terrace I and II			3 (0.5)			1 (0.3)	428 (77.4)		55 (9.9)	11 (2.0)	47 (8.5)	8 (1.4)	553 (100)
Knox Trailer							57 (100)						57 (100)
French Creek	8 (1.4)	1 (0.2)	74 (12.7)	266 (45.6)	3 (0.5)	7 (1.2)		122 (20.9)	22 (3.8)	6 (1.0)	74 (12.7)		583 (100)
Courthouse Bay		73 (28.6)	28 (10.9)	14 (5.5)		12 (4.7)	12 (4.7)	43 (16.9)	15 (5.9)	4 (1.6)	43 (16.9)	11 (4.3)	255 (100)
Onslow Beach	6 (9.8)	1 (1.6)	3 (4.8)	2 (3.2)	1 (1.6)	2 (3.2)		2 (3.2)	12 (19.3)		25 (40.3)	8 (13.0)	62 (100)
Rifle Range		1 (1.3)	1 (1.3)	7 (8.8)	1 (1.3)	5 (6.3)	7 (8.8)	30 (37.5)	5 (6.3)	1 (1.3)	9 (11.3)	13 (16.3)	80 (100)
Camp Geiger	4 (1.9)	15 (6.9)	19 (8.8)	50 (23.1)		23 (10.6)		54 (25.0)	27 (12.5)	2 (1.0)	16 (7.4)	6 (2.8)	216 (100)
Montford Point	6 (2.6)	48 (20.5)	2 (0.9)	4 (1.7)	2 (0.9)	9 (3.9)		82 (35.2)	20 (8.6)	1 (0.4)	49 (21.0)	10 (4.3)	233 (100)
Base-wide Misc.	1 (0.8)			87 (68.0)		3 (2.3)			19 (14.8)			18 (14.1)	128 (100)
TOTAL	**57 (1.1)**	**155 (3.1)**	**287 (5.7)**	**590 (11.7)**	**17 (0.38)**	**186 (3.7)**	**1,523 (30.2)**	**548 (10.8)**	**370 (7.4)**	**65 (1.3)**	**1.116 (22.2)**	**119 (2.4)**	**5,033 (100)**

Point. Altogether, about 29 percent (i.e., 310 acres) of all developed land falls into these two land use categories. Located in the center of this work area are troop housing and associated community uses which are segregated from other similar uses.

Commercial uses on 36 acres are located at three major locations at Hadnot Point. The Main Commissary Exchange is situated on Holcomb Boulevard. Two smaller commercial areas are located within the 2nd Division Regimental areas west of Main Street.

Recreational/open space uses comprise about 17 percent (i.e., 182 acres) of the developed land in Hadnot Point. These areas are distributed mostly on the periphery of each of the troop housing areas.

2.1.9.2 Hospital Point

The major facilities in this area are in the process of being converted from medical to administrative uses. Other uses will remain the same: troop housing exists adjacent to administrative uses, while a second group of troop housing sits between the Marina and family housing. Two enlisted personnel barracks buildings are located adjacent to the family housing area.

Recreational/open space uses in this area front the New River on either side of a smaller group of family housing, creating a picturesque environment that is easily accessible for Hospital Point residents and daytime personnel.

2.1.9.3 Paradise Point

North of Hadnot Point are low-density family housing and recreational area. These two uses make up about 94 percent (i.e., 343 acres and 610 acres, respectively) of all the developed areas on Paradise Point. The golf course, also located in this area, comprises the single largest land use. In the center of the Paradise Point shoreline, is the Bachelor Officers' Housing Area and associated community facilities which are accessible from both troop and family housing areas.

Additional recreational uses, including the only riding stable at MCB Camp Lejeune, are situated between Paradise Point and Berkeley Manor.

2.1.9.4 Berkeley Manor/Watkins Village

Berkeley Manor is characterized by multifamily duplexes in medium density clusters. An elementary school is in the center of the development and the Camp Lejeune High School and a large recreational area lie directly west.

Directly south and adjacent to Berkeley Manor is the Watkins Village townhouse development. This is an attractive, relatively new development situated a short distance from schools, recreational areas, and Hadnot Point.

2.1.9.5 Midway Park

The 248 acres of family housing dominates land use in this area. Community and recreational land uses are located at the entrance to Midway Park. Administrative and storage uses are located behind these areas .

2.1.9.6 Tarawa Terrace I and II

The largest amount of family housing, roughly 428 acres, exists at Tarawa Terrace. Land use arrangements are logical and compatible. These duplexes are arranged around a central area of community uses and the residences are buffered from North Carolina (NC) Route 24 by open recreational and natural wooded areas. All 70 one-bedroom housing units are located at Tarawa Terrace.

2.1.9.7 French Creek

The French Creek area is located southeast of Hadnot Point and is accessible by the Main Service Road. Since its planning in the 1970 Master Plan, French Creek has evolved into a self-supportive, campus-like development. A total of about 583 acres have been developed thus far.

The supply/storage and maintenance facilities, which are situated to the north of the housing areas comprise over 58 percent of the development of French Creek. The largest amount of supply/storage base-wide exists at French Creek. Troop Housing occupies nearly 21 percent (i.e., 122 acres) of the developed area. Ordnance storage areas are grouped to the southeast, with an explosive safety quantity distance arc well outside the development area.

2.1.9.8 Courthouse Bay

Courthouse Bay is located south of Hadnot Point, on the eastern shore of the New River. The area is accessible by Marine's Road and NC Route 172. Courthouse Bay was selected for the Engineers' School and the 2nd Amphibious Tractor Battalion (AMTRAC) because of its protected natural harbor with direct water access.

The 255 acres of development at Courthouse Bay are distributed on the north and south sides of the bay itself, with major land uses in three clusters on the south side. Training facilities, which account for the largest single land use, cover about 73 acres of land. Classroom training facilities and supply and storage buildings for heavy equipment are located in two irregular areas on the south side of the bay, while personnel support, administration, medical facilities, some supply buildings and all of the existing troop housing facilities overlook the New River. Nine family housing quarters are sited along the New River on a peninsula of land which forms the entrance to the bay. Large land areas for heavy equipment training are located further to the southeast and are used by the Engineer's School. An area of maintenance and supply buildings located on the north side of the bay are solely used by the AMTRAC Battalion for maintenance and storage of large vehicles. The area includes a wharf along the bay and a vehicle loading ramp.

2.1.9.9 Mile Hammock Bay

Existing land use is predominantly training and consists of undeveloped trails used by heavy equipment. The existing dock is used for training purposes.

2.1.9.10 Onslow Beach

The primary land use of 25 acres or 40 percent is recreational. A large area of recreational lodges are located northeast of the Onslow Beach Bridge and they are surrounded by supporting community facilities. To the south of this recreational area is troop housing situated on 2 acres, with associated administrative and community uses. A large utility area supports these uses. Segregated further to the southeast is an area of maintenance uses.

2.1.9.11 Rifle Range

Approximately 73 acres of development exists at the Rifle Range. Troop housing straddles both sides of the entrance road and supporting land uses are situated directly behind the housing. This main area permits easy access to the large training range. A small, secondary cluster of barracks and associated administrative and classroom training uses located southeast of the main area are scheduled to be demolished. Site 69 (Rifle Range Chemical Dump) is located approximately one mile southeast of this area.

2.1.9.12 Camp Geiger

A mixture of old and new facilities exists at Camp Geiger, the result of which is a patchwork of land uses arranged in a north to south configuration. The evolution of the approximately 216 acres of development has resulted in uses that are not interrelated, physically or functionally.

Supply and storage, which is concentrated along the eastern edge of the developed area and in the central portion, covers about 50 acres of land. Maintenance uses, which cover about 19 acres, are adjacent to the supply/storage areas. Combined, supply/storage and maintenance areas account for nearly 32 percent of the developed land in Camp Geiger.

No family housing exists at Camp Geiger. Troop housing situated on 54 acres is located in three areas, interspersed with community and commercial uses. Training tends to be conveniently accessible by foot from troop housing although less accessible from community uses, such as the dining facilities. The 16 acres of recreational uses are scarce in terms of number and inconvenient in terms of access.

To comprehensively evaluate existing land use in this area it is important to examine the relationship of Camp Geiger to its neighbor to the south, the MCAS, New River. Recent commercial and community development at the Curtis Road Triangle serves effectively to pull the orientation of Camp Geiger southward.

Site 41 (Camp Geiger Dump Near Former Trailer Park) is located adjacent to U.S. Highway 17 in a heavily wooded area away from residential and/or support areas. Training is conducted on a periodic basis through this area.

2.1.9.13 Montford Point

Montford Point is similar to Camp Geiger in that is is one of the Marine Corps Bases' oldest areas and has seen little planning over the decades. Most of the 233 acres of development are congregated on the eastern side of Montford Landing Road. Of the 233 acres of development, 35 percent (i.e., 32 acres) consist of troop housing. Community facilities are located near the troop housing in the northeast section of the area. The troop housing facilities located at the southern tip of Montford Point have very limited community facilities nearby.

Classroom training facilities are scattered throughout the developed areas of Montford Point. This use constitutes nearly 21 percent (i.e., 48 acres) of the developed area and, therefore, is the second largest land use category existing at Montford Point.

2.1.9.14 Base-Wide

Present military population of Camp Lejeune is approximately 40,928 active duty personnel. The military dependent community is in excess of 32,081. About 36,086 of these personnel and dependents reside in base housing units. The remaining personnel and dependents live off base and have had dramatic effects on the surrounding area. An additional 4,412 civilian employees perform facilities management and support functions. The population of Onslow County has grown from 17,739 in 1940, prior to the formation of the base, to its present population of 121,350.

2.2 Site 69 - Rifle Range Chemical Dump

This section addresses the background and setting of Site 69 (Rifle Range Chemical Dump). In addition, a summary of previous investigations is presented in Section 2.2.6.

2.2.1 Site Location and Setting

Site 69, the Rifle Range Chemical Dump, is located west of the New River estuary in the area of MCB Camp Lejeune known as the Rifle Range. The site is a former disposal ground (i.e., landfill), and is approximately 6 acres in size. The site is heavily wooded with several species of trees, including pine, dogwood and oak. The understory comprises sparse grasses and shrubs (ESE, 1991). Access is restricted by a 6-foot high chain-link fence with a locked entrance gate.

The site is located approximately three miles east-southeast of the intersection of Route 17 and Route 210. The site is situated where a light-duty, unnamed roadway splits to form a "Y." This road shall be referred to in this Work Plan as the "access road."

The New River is located about one-quarter mile east of the site. Everett Creek is located about one-half mile south of the site. An unnamed tributary to the New River is situated about one-quarter mile north of the site. A light duty road borders the site to the west. Both Everett Creek and the unnamed tributary drain into the New River .

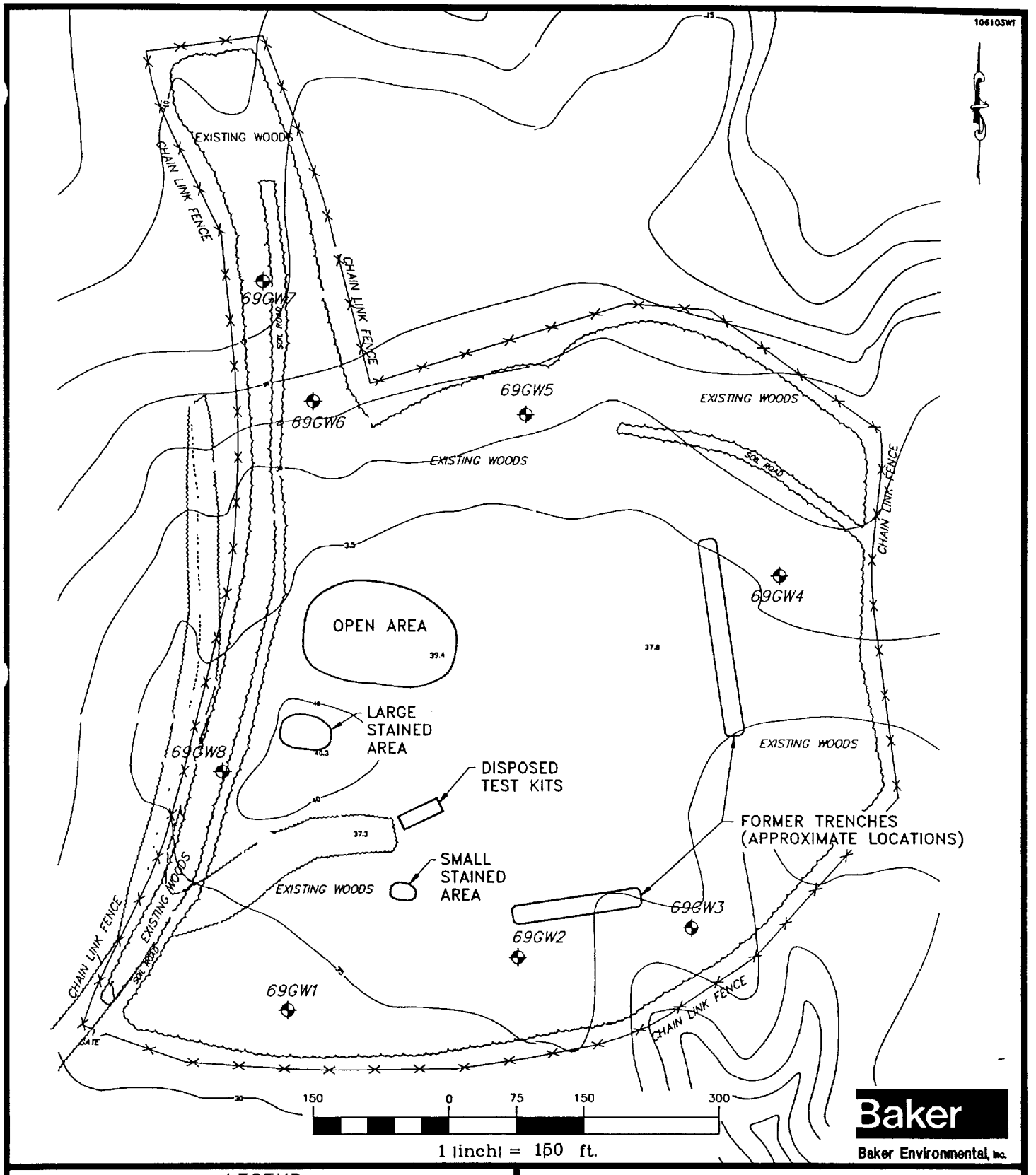
During a site reconnaissance on September 5, 1991, five areas of suspected disposal activities were observed. A brief description of these areas is presented below.

Two areas of stained soils were identified in the south-central portion of the site (Figure 2-4). Both areas were similar in appearance--dark brown seeping soils. The first area, Stained Soil Area No. 1, was approximately 15 feet by 15 feet in area; the second stained area, Stained Soil Area No. 2, was smaller, approximately 7 feet in diameter. High readings on a metal detector were obtained at both of the stained areas. The areas immediately surrounding the two stained locations were covered with undisturbed vegetation and small trees. No particular odors were identified during the site visit.

Immediately north of Stained Soil Area No. 2, the Baker Environmental, Inc., (Baker) team identified what appeared to be a former disposal area approximately 1 to 2 feet wide by 20 feet long. Many glass vials, white powder material, and containers for chemical agent test kits were scattered along the ground surface in this area.

Adjacent to this area, a long trench was observed approximately 75 feet long and 4 to 6 feet wide. The trench surface was covered with vegetation. Numerous mounds of soil were located alongside the trench. Readings from the metal detector were elevated at these mounds. The approximate location of this trench corresponds to a trench identified in the USEPA Environmental Photographic Interpretation Center (EPIC) study. A copy of the EPIC report is provided in Appendix B.

In the north-central portion of the site, an evidently disturbed area was found with a rectangular-shaped covering approximately 0.25 acre. The ground cover and trees in this area presently consist of an immediate growth of lawn vegetation and saplings; the vegetation



LEGEND

69GW2 EXISTING SHALLOW WELL

FENCE

VEGETATION

TOPOGRAPHIC ELEVATION LINES

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 2-4
SITE 69
RIFLE RANGE CHEMICAL DUMP
GENERAL ARRANGEMENT MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

immediately around the area is more dense, and the trees are more mature. No signs of contamination, such as staining or odors, were observed.

2.2.2 Topography and Surface Drainage

Site 69 is situated at a topographic high for the immediate surrounding area. Most of the site within the fence is flat; however, the topography surrounding the site slopes gently in all directions. During the September 1991 site reconnaissance, portions of the site area exhibited standing water, which could indicate poor drainage.

Surface water runoff from the northern portion of the site may drain toward the unnamed tributary located to the north; however, the surrounding area is heavily wooded and consists of a dense understory that could inhibit off-site drainage at great distances. Surface runoff from the southeastern portion of the site apparently drains to unnamed ditches that drain into the New River. Surface runoff from the southwestern portion of the site drains into the Everett Creek basin, which could potentially drain into Everett Creek and the New River. However, as previously mentioned, the surrounding areas are heavily wooded and consist of a thick understory, which could inhibit overland surface runoff at great distances.

2.2.3 Site History

Site 69 was used as a chemical waste dump between 1950 and 1976. The waste materials were reportedly disposed in pits or trenches, 6 to 20 feet deep. Various wastes have been reportedly disposed of at the site, including: polychlorinated biphenyls (PCBs), fire retardants, pentachlorophenol, dichlorodiphenyltrichloroethylene (DDT), trichloroethene (TCE), malathion, diazinon, lindane, calcium hypochlorite, gas cylinders, high-test hypochlorite (HTH), drums of "gas" [possibly training agent containing chloroacetophenone (CN)], chemical agent test kits for chemical warfare, and fired and unfired blank rifle cartridges (Water and Air Research, 1983).

It is also reported that drums containing chemical agents (e.g., mustard gas, blister agents, etc.) were buried at Site 69. Two areas were identified by a civilian employee in October 1982. The employee stated that in 1953, he operated equipment used to bury 55-gallon drums. The employee stated that extensive protective clothing was required, including a gas mask, hood, jacket, and gauntlets. The employee stated that the drums were protected by rubber matting on the bed of the truck, as well as rubber-padded equipment. The original pit was abandoned

after burying approximately 15 drums. The remaining 35 to 40 drums were buried approximately 40 yards away in a single pit. Although it was intended to create a pit 20 feet deep, the sides of the pit caved in repeatedly. In both pits, the drums are reported to be positioned side by side and stacked several rows deep. The top layer of drums is reported to be approximately 5 feet below ground surface (Scudder, 1982).

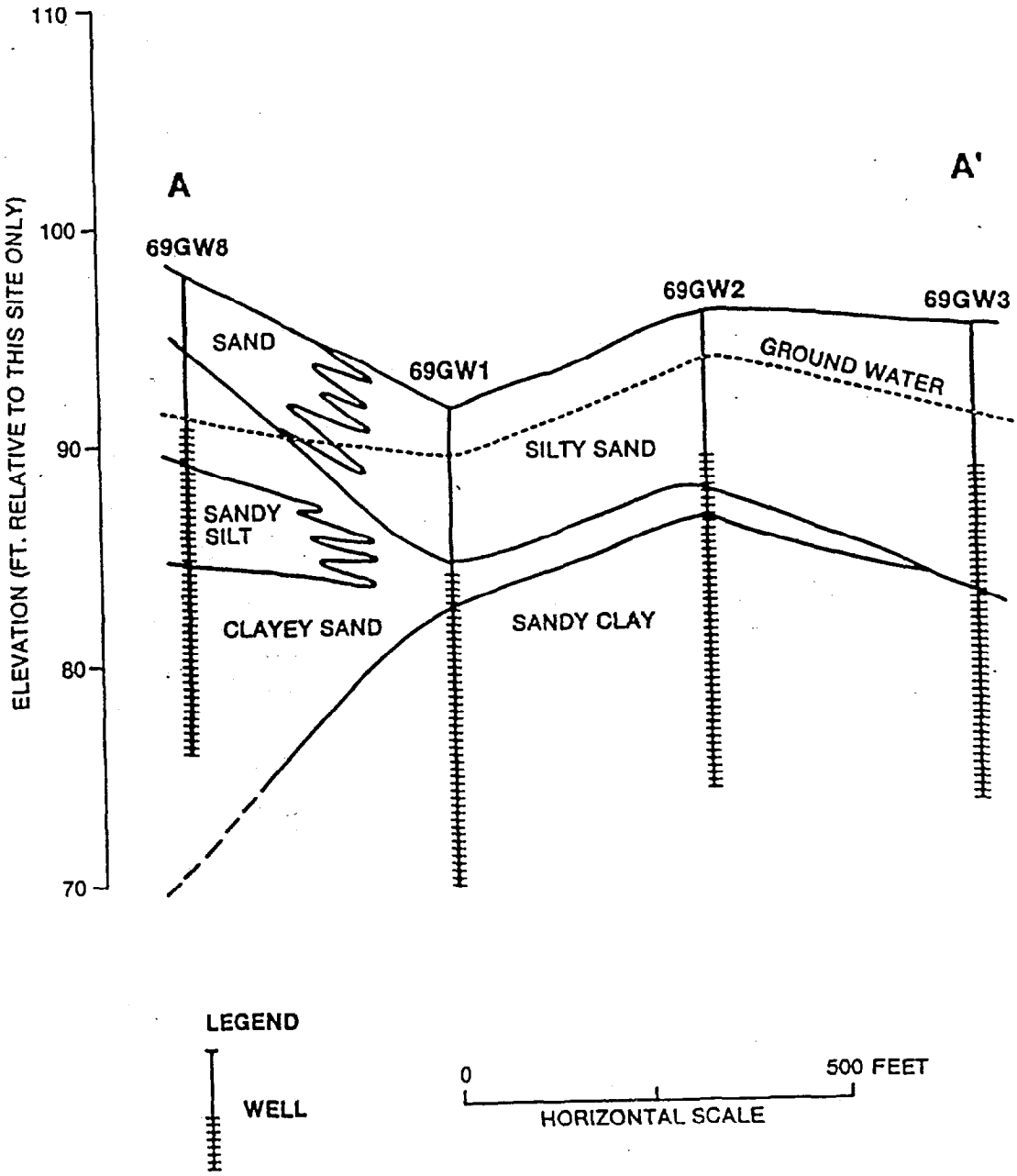
Based on conversations with personnel from The U.S. Army Environmental Center (USAEC) formerly the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) and the U.S. Army Technical Escort Unit (TEU), there is a high probability that chemical agent training kits, as opposed to chemical warfare devices, are buried at the site. PCBs were reportedly sealed in cement septic tanks prior to disposal at the site. The presence of the fired and unfired rifle cartridges indicate that troop-training exercises have occurred in this area (Water and Air Research, 1983).

In 1970, an explosion reportedly occurred at Site 69 during a disposal operation. Containers of DDT, TCE and calcium hypochlorite had been placed in a pit at the site. While the containers were being covered with earth, an explosion and fire occurred (Water and Air Research, 1983).

The site is inactive at present. Access is restricted by a chain-link fence. No known training activities are presently conducted within the fenced-in area.

2.2.4 Site Geology and Hydrogeology

Previous investigative activities at Site 69 involved the drilling of shallow soil borings, and the construction of eight monitoring wells in these borings. The site is reportedly underlain by silty sand and sandy clay with discontinuous layers of clayey sand, sand, sandy silt, and clayey silt (ESE, 1991). Two geologic cross-sections have been provided as Figure 2-5 and 2-6 (ESE, 1991). Figure 2-5 represents the geologic cross-section of the site from a west to east direction, and Figure 2-6 represents the south to north direction. The water table was encountered in silty sand and clayey sand at depths ranging from approximately 5 to 22 feet below ground surface (bgs) in April 1987, and in silty sand, clayey sand, and sandy clay at depths ranging from approximately 7 to 27 feet bgs in January 1991 (ESE, 1991). Table 2-2 presents water level measurements from April 1987 and January 1991.



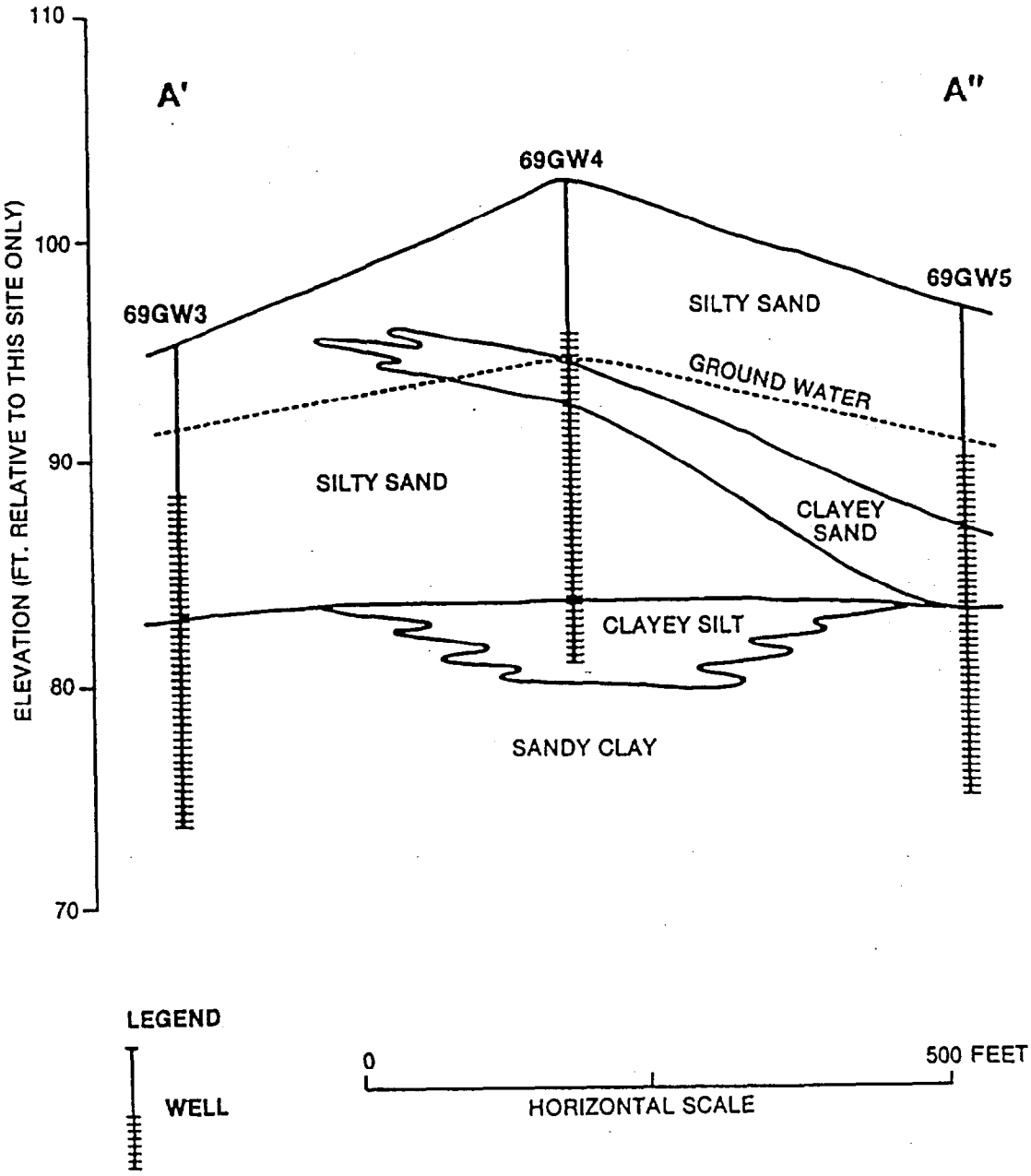
Baker

Baker Environmental, Inc.

FIGURE 2-5
SITE 69
RIFLE RANGE CHEMICAL DUMP
GEOLOGIC CROSS SECTION A-A'

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: ESE, 1991



Baker

Baker Environmental, Inc.

FIGURE 2-6
SITE 69
RIFLE RANGE CHEMICAL DUMP
GEOLOGIC CROSS SECTION A'-A"

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: ESE, 1991

TABLE 2-2

SITE 69 GROUNDWATER ELEVATIONS AND WELL SPECIFICATIONS
MCB CAMP LEJEUNE, NORTH CAROLINA

Well No.(1)	Elevation TOC(2) (feet)	Elevation LS (feet)	Elevation Bottom of Screen(3) (feet)	Stick-Up (feet)	4/15/87		1/18 - 1/19/91	
					DTW - TOC (feet)	Elev - GW (feet)	DTW - TOC (feet)	Elev - GW (feet)
69GW1	94.11	91.64	70.60	2.44	4.92	89.19	12.54	81.57
69GW2	98.99	95.93	75.51	3.06	5.17	93.82	9.60	89.39
69GW3	97.01	95.21	74.86	1.80	5.63	91.38	7.21	89.80
69GW4	101.78	102.39	52.14	-0.61	6.92	94.86	9.25	92.53
69GW5	99.09	96.74	75.76	2.35	8.40	90.69	13.95	85.14
69GW6	92.54	90.70	60.17	1.84	22.08	70.46	26.80	65.74
69GW7	81.73	79.48	58.79	2.25	12.23	69.50	15.29	66.44
69GW8	100.00	97.70	77.3	2.30	8.50	91.50	8.32	91.68

Notes: TOC = Top of Casing
LS = Land Surface
DTW = Depth to Water
GW = Groundwater
Elevations are relative to site only.

(1) All wells constructed of 2-inch PVC casing and Schedule 40 PVC screen.
(2) All measured elevations are relative to the site (e.g., the site is only 30 to 40 feet above msl but the reported elevation is higher than the actual elevation.)
(3) All well screen bottoms were constructed 20 feet below ground surface. Screen lengths are approximately 15 feet.
Source: ESE, 1991.

Groundwater flow may be impacted by watershed boundaries. Shallow groundwater flow is reported to be across the site toward the north and northwest. However, a review of the topography of the site as well as the hydrology of the area indicate that groundwater flow under the eastern portion of the former dump is east-southeast in the southeast section, and east-northeast in the northeast section. Some mounding was reported in the vicinity of well 69GW1; however, it is believed to be localized. Groundwater gradients reportedly average 0.032 ft/ft (ESE, 1982).

2.2.5 Site 69 Land Use and Demographics

The area around Site 69 is used for military training. A fence has been constructed around the site to prevent access. The closest military complex, the Rifle Range, is located approximately one mile northwest of the site. Future land use of the area is reserved for military training only. Hunting is not permitted in the area.

Sensitive environmental areas would include the unnamed tributary to the north of the site and Everett Creek to the south. Both of these water bodies are in a coastal wetland. There are no sensitive human receptors within one mile of the site area. An elementary school is located approximately two miles west of the site.

2.2.6 Previous Investigations and Findings

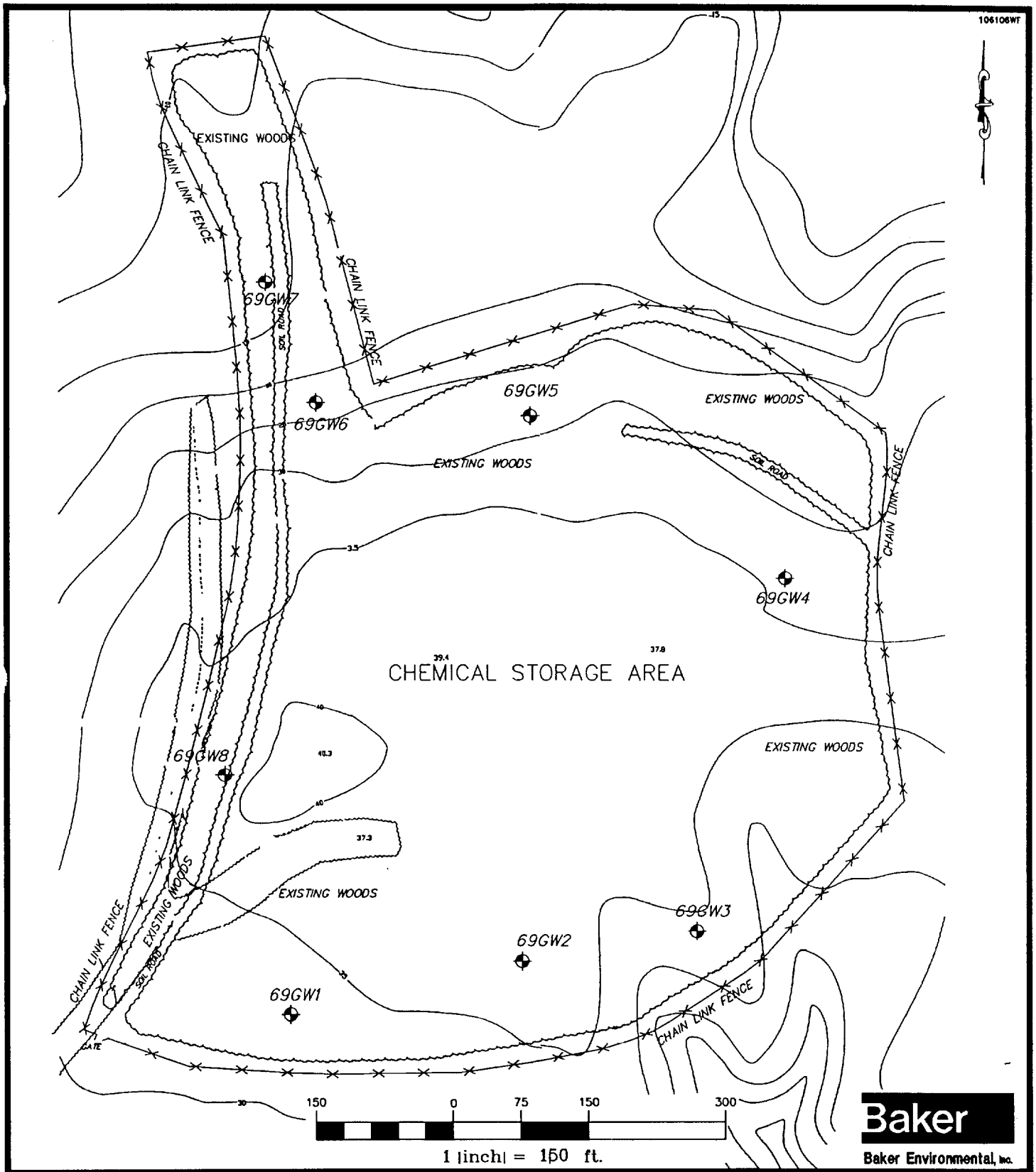
This section summarizes the results of previous environmental investigations. A detailed description of the investigations, including tables, can be found in ESE's 1991 report.

2.2.6.1 Soil

No soil samples have been collected at Site 69, Rifle Range Chemical Dump.

2.2.6.2 Groundwater

As part of the Verification Step conducted in July 1984, eight groundwater monitoring wells were installed and sampled at Site 69 (Figure 2-7). The samples were analyzed for PCBs, pentachlorophenol, residual chlorine, organochlorine pesticides, mercury and volatile organic compounds (VOCs). PCBs, pentachlorophenol, and chlorine were not detected in the samples. Mercury was detected, but at levels significantly lower than the North Carolina Groundwater



LEGEND

69GW2 EXISTING SHALLOW WELL

FENCE

VEGETATION

TOPOGRAPHIC ELEVATION LINE

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 2-7
SITE 69
RIFLE RANGE CHEMICAL DUMP
EXISTING GROUNDWATER
SHALLOW MONITORING WELL LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Standard of 1.1 micrograms/liter (µg/L). Samples from monitoring wells located along the southern and eastern portion of the site (i.e., wells 69GW1, 69GW3, and 69GW4), however, contained VOCs such as benzene, 1,2-dichloroethane, trans-1,2-dichloroethene, trichloroethene, toluene, and vinyl chloride.

In December 1986, a second round of groundwater samples was collected from the eight monitoring wells. This sampling was conducted as part of the Characterization Step. The samples were analyzed for the same compounds as the 1984 round plus tetrachlorodioxin, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), and ethylene dibromide. The results from this sampling were similar to those of the 1984 sampling; various VOCs were detected primarily in wells 69GW1, 69GW2, 69GW3, and 69GW4.

As part of the Supplemental Characterization Step, the eight monitoring wells were sampled in January 1991. The samples were analyzed for full target compound list (TCL) organics. Pesticides and semivolatiles were not detected in the samples. As with the other rounds of sampling, various VOCs were detected: carbon disulfide, 1,2 - dichloroethelyene (1,2-DCE) (11,000 µg/L maximum), TCE (67 µg/L maximum), vinyl chloride (36 µg/L maximum), and chlorobenzene (40 µg/L maximum). Detected inorganics included aluminum (2,300 - 43,800 µg/L), antimony (68.5 µg/L), arsenic (2.8 - 11.0 µg/L), barium (36.6 - 153 µg/L), beryllium (0.85 - 3 µg/L, calcium (2,500 - 8,330 µg/L), chromium (5.3 - 47 µg/L), cobalt (8.6 - 9.7 µg/L), copper (4.9 - 27.5 µg/L), cyanide (11.2 µg/L), iron (7,740 - 792,000 µg/L), lead (2.6 - 23.9 µg/L), magnesium (1,970 - 4,410 µg/L), manganese (4.6 - 230 µg/L), nickel (5.7 - 27.6 µg/L), potassium (1,450 - 4,190 µg/L), silver (1.6 - 6.5 µg/L), sodium (4,880 - 18,900 µg/L), thallium (4.9 - 5.2 µg/L), vanadium (6.1 - 2,240 µg/L), and zinc (51.8 - 10,200 µg/L) (ESE, 1992).

Wells 69GW2 and 69GW3 have historically exhibited the highest levels of VOCs. Groundwater flow direction in this portion of the site is believed to be southeast, based on the topography of this area and the drainage pattern. Table 2-3 summarizes the detected organic analytes in groundwater.

2.2.6.3 Surface Water

Surface water and sediment samples were collected during various investigations at Site 69. These investigations were conducted in August 1984 (Verification Step), December 1986 (Characterization Step), and January 1991 (Supplemental Characterization Step).

TABLE 2-3

SITE 69 - RIFLE RANGE CHEMICAL DUMP
DETECTED TARGET ANALYTES IN GROUNDWATER SAMPLES
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Federal MCLs	NC Groundwater Standards	Sample No./Date							
			69GW1 7/18/84	69GW1 12/12/86	69GW2 7/18/84	69GW2 12/17/86	69GW3 7/18/84	69GW3 12/17/86	69GW4 7/18/84	69GW4 12/18/86
Mercury	2	1.1	0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2
beta-BHC	None	None	<0.0001	<0.013	<0.0001	<0.013	<0.0001	0.087	<0.0001	<0.013
delta-BHC	None	None	<0.0003	NR	<0.0003	0.034	<0.0003	2.44	<0.0003	<0.013
1,2-Dibromomethane	None	None	NA	<0.02	NA	4.74	NA	0.363	NA	<0.02
Benzene	5	1	<0.3	<1	0.7	<25	4	4	<0.6	<1
Chlorobenzene	100	300	<0.5	<6	<0.5	<150	49	55	<0.9	<6
Chloroform	None	0.19	<0.7	<1.6	<0.6	<40	<0.6	<1.6	1.3	14
1,2-Dichloroethane	5	0.38	<1	<2.8	5.9	<70	1.9	<2.8	<1.8	<2.8
1,1-Dichloroethylene	7	7	<1.2	<2.8	1.6	<70	2.7	<2.8	<2.4	<2.8
trans-1,2-Dichloroethene	100	70	<1.2	<1.6	9700	37000	4000	830	410	91
Methylene chloride	None	5	10	<2.8	<1	<70	<1	<2.8	<2	<2.8
1,1,2,2-Tetrachloroethane	None	None	<0.9	<4.1	44	<100	<0.8	<4.1	2	5.4
Tetrachloroethene	5	None	<1.7	<3	20	<75	<1.6	<3	<3.3	<3
1,1,2-Trichloroethane	5	None	<1.2	<5	7.9	<130	<1.2	<5	3.1	<5
Trichoroethene	5	None	<1.3	<3	340	710	4.9	<3	<2.5	<3
Toluene	1,000	1,000	0.7	<6	5	<150	14	10	<1	<6
Vinyl chloride	2	0.015	<0.9	<1	80	440	2	1.6	<2	<1

TABLE 2-5 (Continued)

SITE 69 - RIFLE RANGE CHEMICAL DUMP
DETECTED TARGET ANALYTES IN GROUNDWATER SAMPLES
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Federal MCLs(1)	North Carolina WQS (2)	Sample ID/Date Samples							
			69GW5 7/18/84	69GW5 12/18/86	69GW6 7/18/84	69GW6 12/18/86	69GW7 7/18/84	69GW7 12/18/86	69GW8 7/18/84	69GW8 12/18/86
Mercury	2	1.1	<0.2	<0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2
beta-BHC	NS	NS	<0.0001	<0.017	<0.0001	<0.013	<0.0001	<0.013	<0.0001	<0.013
delta-BHC	NS	NS	<0.0003	<0.017	<0.0003	<0.013	<0.0003	<0.013	<0.0003	<0.013
1,2-Dibromomethane	NS	NS	NA	<0.02	NA	<0.02	NA	<0.02	NA	<0.02
Benzene	5	1	<0.3	<1	<0.3	<1	<0.3	<1	<0.3	<1
Chlorobenzene	100	300	<0.5	<6	<0.5	<6	<0.5	<6	<0.5	<6
Chloroform	NS	0.19	<0.7	<1.6	<0.6	<1.6	<0.7	<1.6	<0.7	<1.6
1,2-Dichloroethane	5	0.38	<1	<2.8	<0.9	<2.8	<1	<2.8	<1	<2.8
1,1-Dichloroethylene	7	7	<1.2	<2.8	<1.2	<2.8	<1.2	<2.8	<1.3	<2.8
trans-1,2-Dichloroethene	100	70	<1.2	4.2	<1.2	<1.6	<1.2	<1.6	<1.2	<1.6
Methylene chloride	NS	5	<1	<2.8	<1	<2.8	<1	<2.8	<1	<2.8
1,1,2,2-Tetrachloroethane	NS	NS	<0.9	<4.1	<0.8	<4.1	<0.9	<4.1	<0.9	<4.1
Tetrachloroethene	5	NS	<1.7	<3	<1.6	<3	<1.7	<3	<1.7	<3
1,1,2-Trichloroethane	5	NS	<1.2	<5	<1.2	<5	<1.2	<5	<1.2	<5
Trichoroethene	5	NS	<1.3	<3	<1.3	<3	<1.3	<3	<1.3	<3
Toluene	1,000	1,000	<0.6	<6	<0.6	<6	<0.6	<6	<0.6	<6
Vinyl chloride	2	0.015	<1	<1	<0.9	<1	<1	<1	<0.9	<1

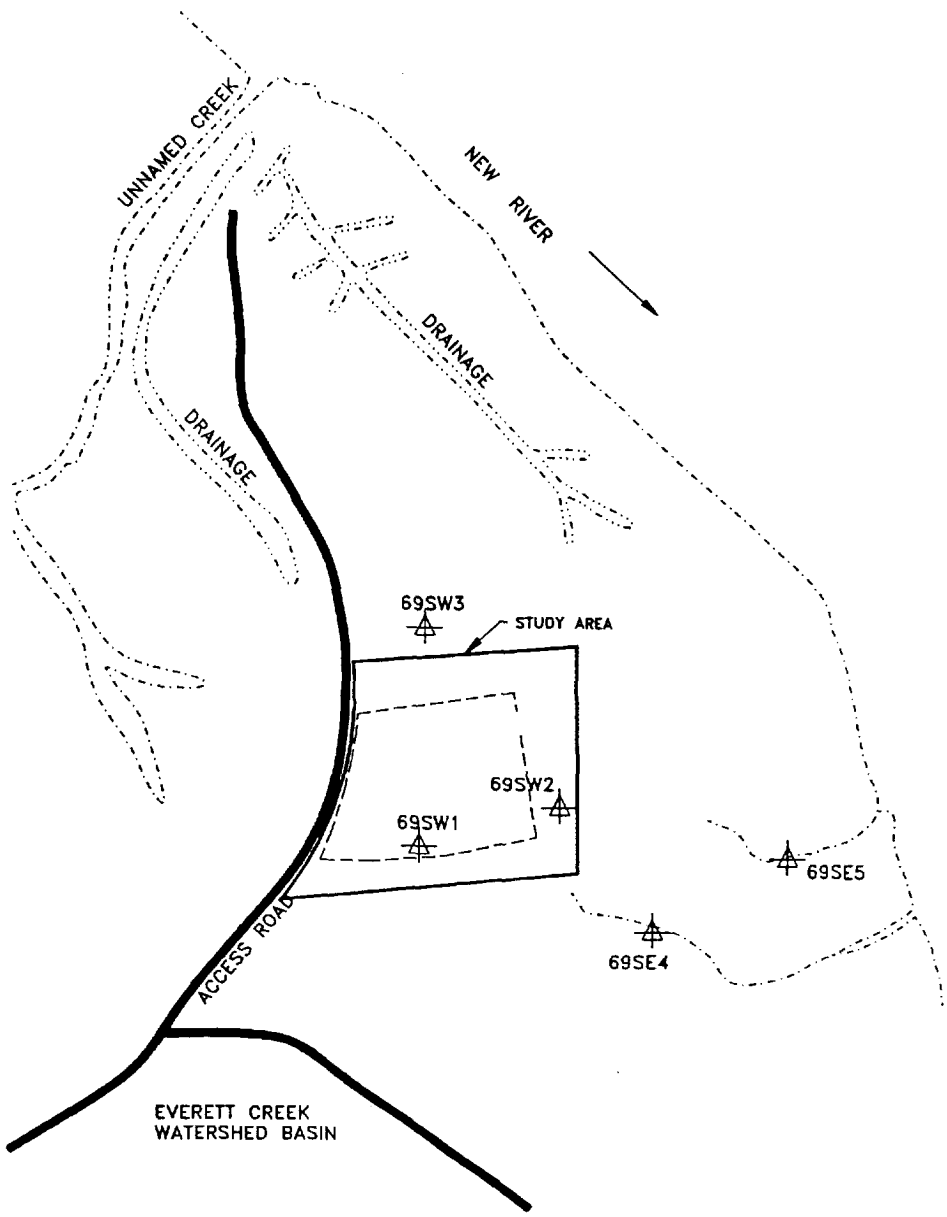
NS = No Standard Established NA = Not Analyzed
Values reported are concentrations in micrograms per liter (µg/L); this approximates parts per billion (ppb).
Source: ESE, 1992.
(1) Federal maximum contaminant levels (MCLs) established under the Safe Drinking Water Act of 1986.
(2) NCWQS - North Carolina administrative code, Title 15, N.C. DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards (WQS) for groundwater, August 4, 1989. Class GA Standards.

In 1984, two surface water samples were collected from low-lying ponding areas in the vicinity of the former disposal area. No sediment samples were obtained at either location. The results indicated that sampling station 69SW1 (see Figure 2-8) was highly contaminated with VOC contaminants. Sampling station 69SW2 also exhibited VOC contamination, but to a lesser degree. The results are summarized on Table 2-4.

During the Characterization Step in December 1986, three surface water samples were collected from three small water-filled depressions around Site 69. One depression was near the southern edge of the site; the second depression was immediately east of the site; and the third depression was north of the site. The samples were analyzed for organochlorine pesticides, PCBs, pentachlorophenol, VOCs, mercury, residual chlorine, tetrachlorodioxin, MEK, MIBK, and ethylene dibromide. Pentachlorophenol (1.24 µg/L maximum) and VOCs, such as trans-1,2-DCE (310 µg/L maximum), TCE (63 µg/L maximum), and vinyl chloride (41 µg/L maximum), were detected in the on-site sample 69SW1, and the eastern sample 69SW2. No VOCs were detected in the sample 69SW3 collected north of the site; however, low levels of mercury (0.20 µg/L) were detected at this location.

Surface water and sediment sampling locations for the 1986 round of sampling are provided in Figure 2-8 (ESE, 1991). A summary of contaminants detected during the Verification Step (1984) and Characterization Step (1986) is provided in Table 2-4.

In January 1991, three surface water samples were collected as part of a Supplemental Characterization Study. One sample was collected at the same southern-edge location sampled in 1986, the water-filled depression. The remaining two samples were collected from two unnamed tributaries that drain from the site into the New River estuary, east-southeast of the site. The samples were collected near the confluence of the New River and analyzed for full TCL parameters. Pesticides and semivolatiles were not detected in any of the samples. VOCs were detected in the water-filled depression sample 69SW1. No VOCs were detected in the other two samples. Inorganics detected in the samples included aluminum (309 - 622 µg/L), barium (28.2 µg/L), calcium (3,630 - 241,000 µg/L), copper (6.4 µg/L), cyanide (11.2 µg/L), iron (159 - 4,420 µg/L), magnesium (986 - 753,000 µg/L), manganese (223 µg/L), potassium (710 - 318,000 µg/L), silver (2.4 - 3.1 µg/L), sodium (5,090 µg/L), vanadium (5 µg/L), and zinc (1,960 µg/L) (ESE, 1992). Surface water sampling locations for the 1991 round of sampling are provided in Figure 2-9. A summary of organic contaminants detected in surface water is provided in Table 2-4.



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LEGEND

PREVIOUS SURFACE WATER/ SEDIMENT SAMPLE LOCATION

REPORTED LANDFILL BOUNDARY

SOURCE: ESE, 1991

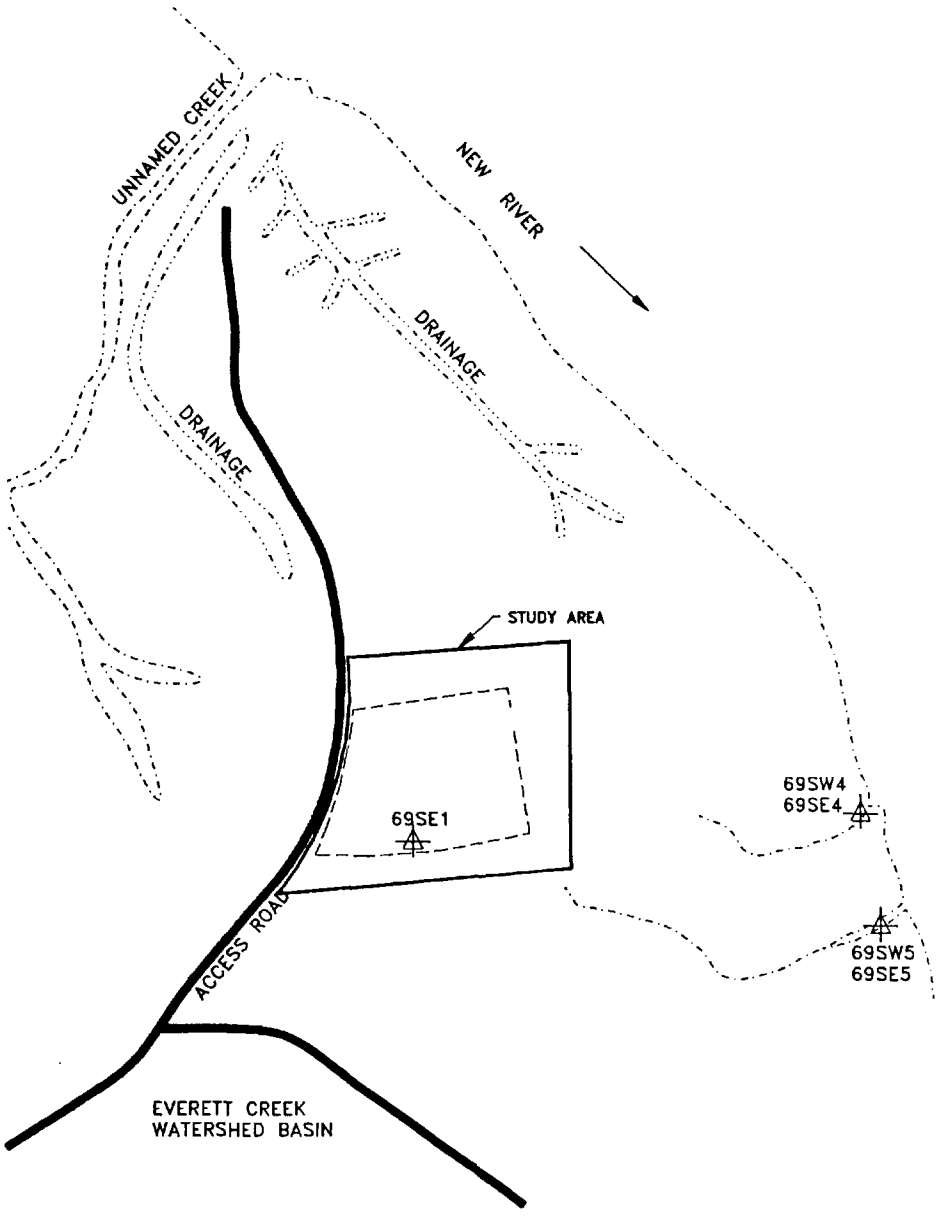
FIGURE 2-8
SITE 69
RIFLE RANGE CHEMICAL DUMP
PREVIOUS SURFACE WATER/
SEDIMENT SAMPLING LOCATIONS (1984/1986)
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

TABLE 2-4

SITE 69 - RIFLE RANGE CHEMICAL DUMP
DETECTED TARGET CONTAMINANTS IN SURFACE WATER SAMPLES
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Federal Ambient Water Quality Criteria		Sample No./ Date							
			Verification Step		Characterization Step			Supplemental Characterization		
	Organisms(1)	Health(2)	69SW1 8/4/84	69SW2 8/4/84	69SW1 12/12/86	69SW2 12/12/86	69SW3 12/12/86	69SW1 1/14/91	69SW4 1/14/91	69DW5 1/14/91
alpha-BHC	NS	NS	<0.001	<0.001	0.043	0.056	<0.035	<0.05	<0.05	<0.05
beta-BHC	NS	NS	0.03	0.005	0.043	0.18	<0.013	<0.05	<0.05	<0.05
delta-BHC	NS	NS	0.2	0.02	NR	NR	NR	<0.05	<0.05	<0.05
Pentachlorophenol	13	1,000	10	<0.9	<0.89	1.24	<0.89	<50	<100	<50
Benzene	NS	0.66	0.4	<0.2	<1	<1	<1	<5	<5	<5
Chlorobenzene	NS	488	2.1	<0.3	<6	<6	<6	<5	<5	<5
Chloroform	1,240	0.19	6	<0.5	<1.6	<1.6	<1.6	3J	<5	<5
1,2-Dichloroethane	20,000	0.94	0.9	<0.8	<2.8	<2.8	<2.8	<5	<5	<5
trans-1,2-Dichloroethene	NS	NS	410	10	310	170	<1.6	190	<5	<5
Ethylbenzene	NS	1,400	3	<0.6	<7.2	<7.2	<7.2	<5	<5	<5
Methylene chloride	NS	NS	<0.6	8	<2.8	<2.8	<2.8	<5	1BJ	<5
1,1,2,2-Tetrachloroethane	2,400	0.17	59	<0.5	<4.1	<4.1	<4.1	5	<5	<5
1,1,2-Trichloroethane	9,400	0.6	6	<0.8	<5	<5	<5	<5	<5	<5
Trichoroethene	21,000	2.7	55	1.3	63	12	<3	7	<5	<5
Toluene	NS	14,000	11	<0.4	<6	<6	<6	2J	<5	<5
Vinyl chloride	NS	2	15	<0.6	41	<1	<1	15	<5	<5
Mercury	0.012	0.144	<0.2	<0.2	<0.2	<0.2	0.2	<0.10	<0.10	<0.10

NA = Not Analyzed NS = No Standard Established
(1) Freshwater Chronic Criteria. (2) Protection of Human Health - Water and Organisms
Values reported are concentrations in micrograms per liter (µg/L); this approximates parts per billion (ppb).
Source: ESE, 1992.



N.T.S.

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LEGEND

- PREVIOUS SURFACE WATER/ SEDIMENT SAMPLE LOCATION
- REPORTED LANDFILL BOUNDARY

SOURCE: ESE, 1991

FIGURE 2-9
SITE 69
PREVIOUS SURFACE WATER/
SEDIMENT SAMPLING LOCATIONS (1991)
RIFLE RANGE CHEMICAL DUMP
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

In August 1992, surface water/sediment samples were collected along the New River, Everett Creek, and an unnamed tributary to the river, as part of an Ecological Risk Assessment. In addition, a benthic and fish population study and fish tissue sampling was conducted. The technical analysis of the results of the chemical analyses is in progress. The Ecological Risk Assessment Report will be submitted with the Site 69 Remedial Investigation Report and Feasibility Study.

2.2.6.4 Sediment

As part of the Characterization Step conducted in December 1986, two sediment samples were collected from two unnamed tributaries that drain from Site 69 into the New River estuary (see Figure 2-8). The two tributaries are located east-southeast of the site. The samples were analyzed for organochlorine pesticides, PCBs, pentachlorophenol, VOCs, mercury, residual chlorine, tetrachlorodioxin, MEK, MIBK, and ethylene dibromide (ESE, 1991). The only compounds detected in these samples included dichlorodiphenyldichloroethane (DDD) (0.113 µg/g), dichlorodiphenyldichloroethylene (DDE) (0.0188 µg/g), and pentachlorophenol (1.190 µg/g). Sediment sampling locations for the 1986 round of sampling are provided in Figure 2-8.

In January 1991, three sediment samples were collected at the same locations where surface water samples were collected. The samples were analyzed for full TCL organics. No VOCs, pesticides, or semivolatiles were detected in the samples. Inorganics detected in the samples included aluminum (1,950 - 2,650 mg/kg), antimony (3.4 - 9.70 mg/kg), barium (3.2 - 7.6 mg/kg), beryllium (0.74 mg/kg), cadmium (0.73 - 1.80 mg/kg), calcium (30.8 - 486 mg/kg), chromium (3.5 - 6.4 mg/kg), copper (0.69 - 2.0 mg/kg), iron (1,500 - 2,890 mg/kg), lead (1.7 - 3.1 mg/kg), magnesium (74.2 - 902 mg/kg), manganese (2.0 - 12.4 mg/kg), potassium (456 - 582 mg/kg), silver (0.97 mg/kg), sodium (76.1 - 3,290 mg/kg), vanadium (3.0 - 6.90 mg/kg), and zinc (6.10 - 19.5 mg/kg). Sediment sampling locations for the 1991 round of sampling are provided in Figure 2-9.

In August 1992, sediment samples were collected along the New River, Everett Creek, and an unnamed tributary to the river, as part of an Ecological Risk Assessment for Site 69. The technical analysis of the results of the chemical analyses is in progress.

2.2.6.5 Tissue Sampling

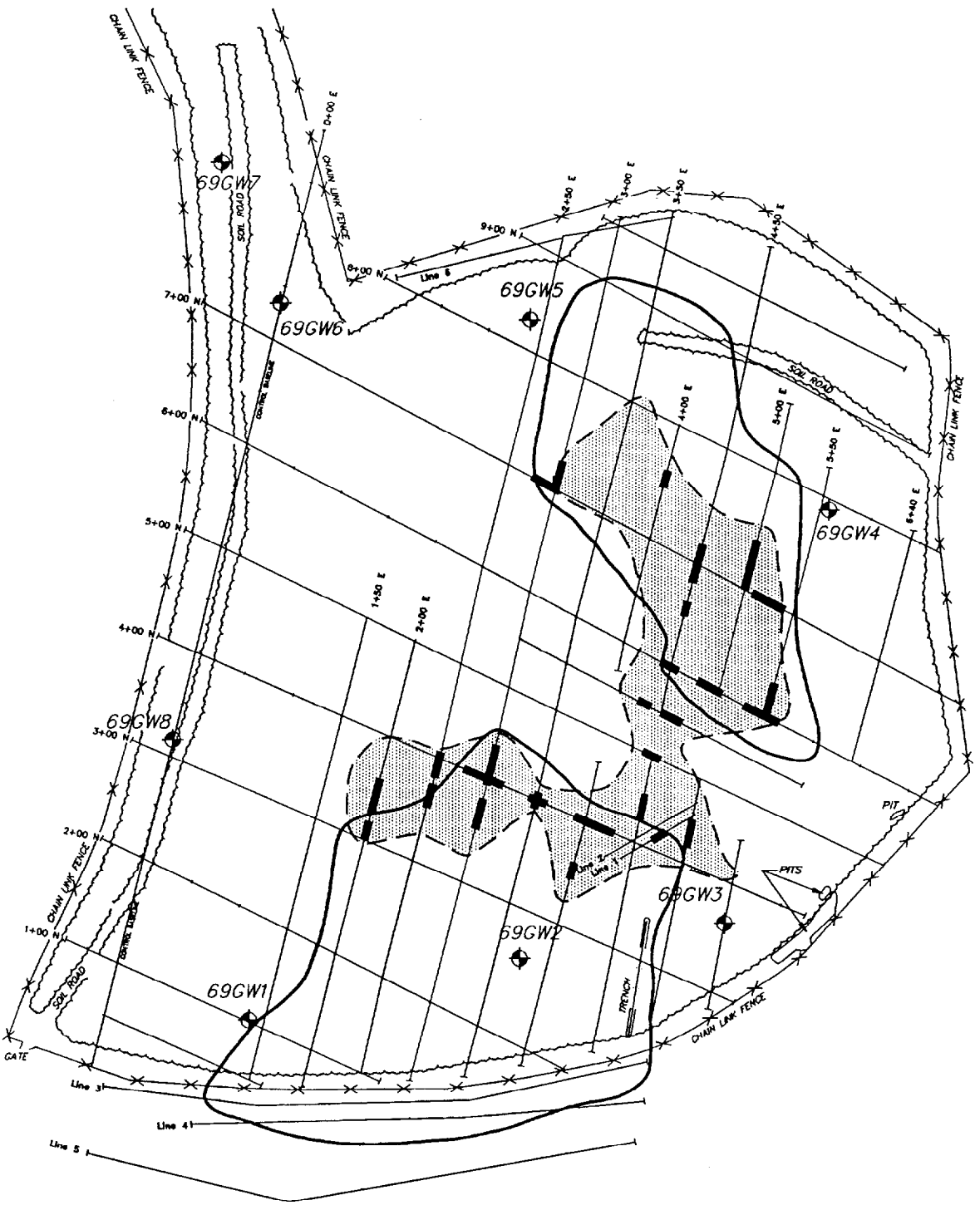
Fish tissue sampling was performed in January 1991 in the New River estuary. The area was shallow, with an average depth of two feet. Due to the lack of fish, shellfish (i.e., oysters and mussels) were collected and composited to form four samples. The samples were analyzed for full TCL organics and TAL inorganics. No PCBs or and pesticides were detected in any of the samples.

Benzoic acid was detected in four tissue samples ranging from 520 to 2,300 µg/L. Phenol was detected in two samples (250 and 300 mg/L). The only VOCs detected include chloromethane and acetone. Chloromethane was detected in all four samples at concentrations ranging from 17 to 210 µg/kg, and acetone was detected in only one sample at a concentration of 28,000 µg/kg. The report, however, excluded acetone as a contaminant of concern since it is a known laboratory contaminant. Inorganics detected in all four samples included aluminum (106 to 1,740 µg/kg), arsenic (0.5 to 1 µg/kg), calcium (2,840 to 15,900 µg/kg), chromium (0.7 to 162 µg/kg), copper (4.8 to 52.4 µg/kg), iron (128 to 1,790 µg/kg), magnesium (722 to 892 µg/kg), manganese (1.6 to 7.10 µg/kg), lead (2 to 2.2 µg/kg), nickel (0.8 to 7.5 µg/kg), potassium (1,160 to 1,670 µg/kg), selenium (0.3 to 0.4 µg/kg), silver (0.3 to 0.4 µg/kg), sodium (4,440 to 4,930 µg/kg, vanadium (0.3 to 3.6 µg/kg) and zinc (92.9 to 151 µg/kg).

In August 1992, aquatic organism samples were collected along the New River, Everett Creek, and an unnamed tributary to the river, as part of an Ecological Risk Assessment. The technical analysis of the results of the chemical analyses is in progress.

2.2.6.6 Geophysical Investigation

Geophysical surveys were conducted at Site 69 in Summer and Fall of 1992. At Site 69, lateral changes in conductivity were observed across two broad areas located in the south and north portions of the site. In the central portion of the site and partially coincident with the increased conductivities, buried metallic and ferrous metallic objects were detected. The greater lateral extent of increased conductivity relative to that of the buried metal locations, may indicate the previous widespread burial of non-metallic materials and/or the limits of a conductive contaminant plume. The areas identified with geophysics appear to be coincident with burial trenches identified on 1956, 1958, and 1964 aerial photographs by EPIC. The boundaries of buried metallic and ferrous metallic objects are depicted on Figure 2-10.



LEGEND

- MONITORING WELL
- EM AND MAG SURVEY LINE
- INTERPRETED LIMIT OF INCREASED CONDUCTIVITY(>10 mmhos/m) INDICATIVE OF BACKFILL MATERIALS AND/OR CONTAMINANT PLUME
- INTERPRETED LIMIT OF INCREASED MAGNETIC INTENSITY INDICATIVE OF BURIED FERROUS METAL
- BURIED METALLIC OBJECT
- FENCE
- VEGETATION

SOURCE: WESTON GEOPHYSICAL CORP., MARCH 1993

FIGURE 2-10
SITE 69
RIFLE RANGE CHEMICAL DUMP
EM AND MAG SURVEY RESULTS

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

2.3 Site 74 - Mess Hall Grease Pit Disposal Area

This section addresses the background and setting of Site 74. A summary of previous investigations is also presented in Section 2.3.5.

2.3.1 Site Location and Setting

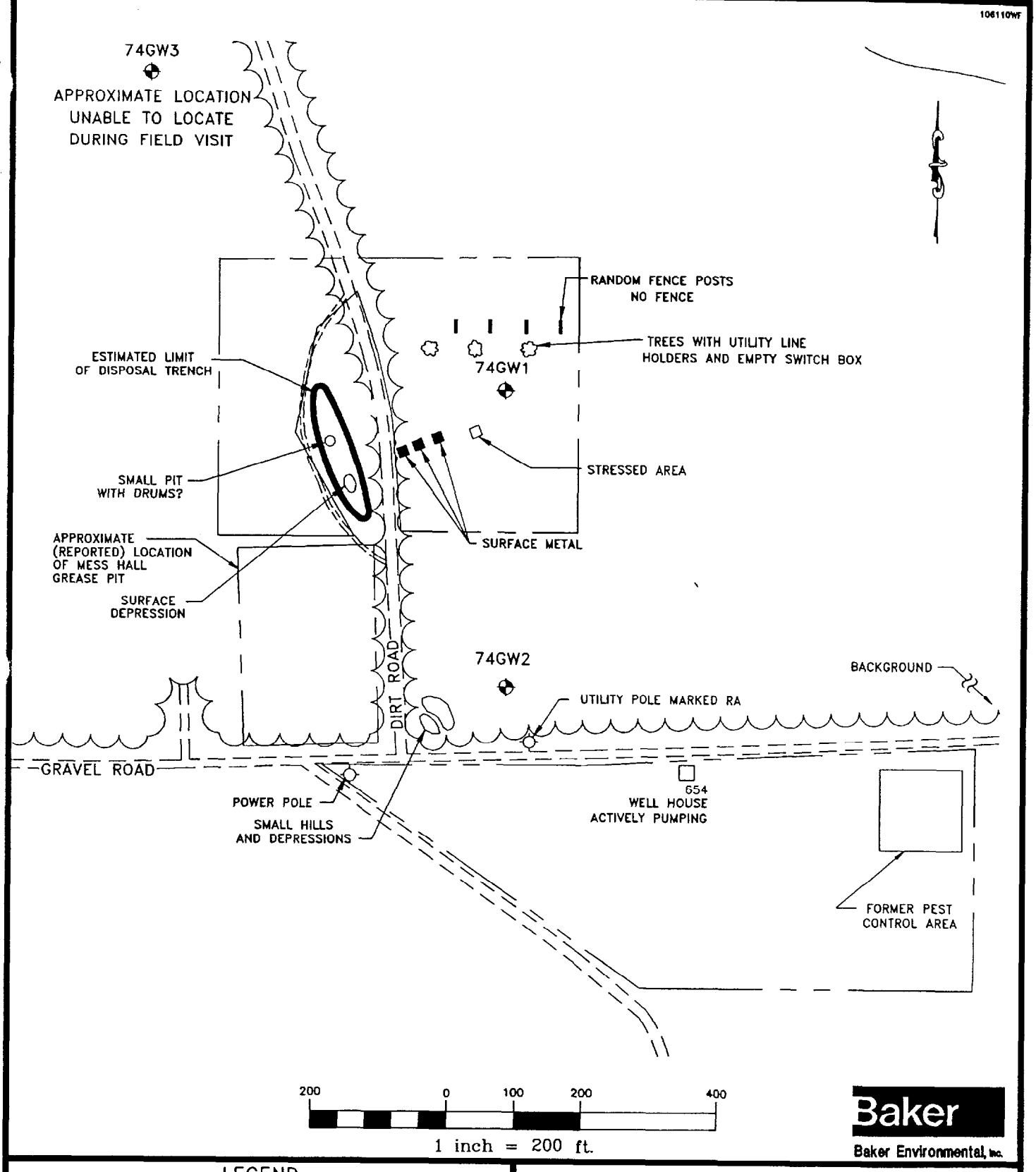
Site 74 the Mess Hall Grease Pit Disposal Area (Figure 2-11) is located in a stand of woods approximately 1/2 mile east of Holcomb Boulevard in the northeast portion of MCB Camp Lejeune (PWDM coordinates 5, N13/014). There are two areas of concern at Site 74: the Grease Pit Disposal Area and the Former Pest Control Area. The Mess Hall Grease Pit Disposal Area north of the gravel road, and west of the dirt-access road is approximately three acres in size. The grease pit reportedly measures 135 feet long, 30 feet wide, and 12 feet deep. The Pest Control Area is located approximately 20 to 50 yards south of the grease pit and 75 yards east of Supply Well 654. The total size of the Pest Control Area has been estimated at 100 feet by 100 feet (Water and Air Research, 1983). The area which surrounds the former pest control area may also be associated with disposal operations based on historical aerial photographs.

Both areas are overgrown with vegetation and trees, and is predominantly flat. There are some signs of previous disposal activities. One former trench is somewhat discernible; drum fragments were observed penetrating the surface just west of a dirt access road (see Figure 2-11). The former location of the grease pit (at the intersection of the dirt road and gravel road) is also discernible, but not apparent. The former grease pit area sits somewhat lower than the dirt access road. During some of the previous site visits, the area was covered with water, indicating a poor drainage area.

The former pesticide control area is heavily vegetated. The former pest control building is no longer present. The foundation is barely discernible. The surrounding area mentioned previously is also heavily vegetated. Supply well 654 is present and operational. There are no apparent signs of former disposal/pesticide handling activities in this area.

2.3.2 Topography and Surface Drainage

The land is primarily flat. A low area is present at the location of the former grease pit, west of the dirt access road. This low area is occasionally ponded during periods of heavy



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74GW2 – EXISTING SHALLOW WELL

– VEGETATION

– ROAD (UNIMPROVED)

SOURCE: REVISED FROM LANTDIV. OCT. 1991

FIGURE 2-11
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA
GENERAL ARRANGEMENT MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

precipitation. Ponded water from this area percolates to the water table. There are no noticeable drainage pathways other than this low-lying portion of the site.

2.3.3 Site History

Information reviewed in the IAS Report indicated that three separate activities occurred at Site 74: the disposal of grease/food into a large pit; burials of 55-gallon drums near the grease pit, possibly containing PCB transformer oil and pesticides; and the disposal of pesticide-soaked bags of sawdust in wetland areas for mosquito control. The actual "wetland" area described in this report was not located. There are no apparent wetlands in the site area. A site reconnaissance will be conducted to delineate wetland areas near the site.

Grease disposal activities reportedly occurred in the early 1950s. At least one attempt to burn the grease using a more flammable substance failed. In 1954, Hurricane Hazel passed through the area and washed/floated the grease from the pit. The use of the pit was discontinued. The disposal of about 20 drums of PCB containing transformer oil reported occurred about 1963. The pest control activities reportedly occurred during the period 1950-1958. Pesticide drum burials were reported to occur in the early 1950s. One or more truckloads of pesticides in 55-gallon drums were disposed of at this site. (Water and Air Research, 1983).

It is also important to note that some drums may have been left over from a burial/disposal incident at the Rifle Range Chemical Dump (Site 69). Since drums containing chemical agents are reportedly buried at Site 69, it is possible that drums containing chemical agents are also buried at Site 74. There is no documentation with respect to the drums contents that were originally planned for disposal at Site 69 but were disposed of at Site 74.

Historical photographs indicate that in the mid 1950s, the former pest control area was used as either a disposal area, or a staging area for fill (see Appendix B). Multi-toned mounded materials are depicted in the 1956 aerial photograph. It is unknown whether this material is simply piles of soil, or waste. Since that time, no significant activity in this area has been documented via aerial photographs. In addition, no disposal events have been documented in Navy/Marine Corps memorandums. The initial Assessment Report (Water and Air Research, 1983) indicate that a sand mining site was used in the sawmill-grease pit area concurrently with the grease pit operation. The multi-toned mounded material depicted in the 1956 aerial photograph, therefore, could have been sand/soil.

Several trenches near the former grease pit, primarily north of the grease pit, are depicted in aerial photographs. These trenches may be associated with the disposal of pesticide, PCB, or chemical agent wastes in drums.

2.3.4 Site Geology and Hydrogeology

Site 74 is underlain primarily by sand and silty sand. The shallow groundwater lies within the silty sand. The depth to the groundwater was measured to be between 2.01 to 12.2 feet bgs. Shallow groundwater flows east at an approximate gradient of 0.014 ft/ft. A geologic cross-section of Site 74 has been provided in Figure 2-12. This geologic cross-section of the site represents a west to east direction.

2.3.5 Site 74 Land Use and Demographics

The area around Site 74 is occasionally used for military training. The closest military complex is associated with a water treatment plant and administrative building located about one-half mile west of the site. Midway Park, a large housing development, is located about one mile northwest of the site. Future land use of the area is reserved for military training. Hunting is permitted in the area; however, passes must be issued so that hunting activities do not conflict with military training.

The upper reaches of Wallace Creek, located approximately two miles southeast of the site, is designated as a natural area. There are no sensitive ecological populations reported to habitat the site area.

2.3.6 Previous Investigations and Findings

Previous investigations at Site 74 focused on soil and groundwater. There is no on-site surface water. Henderson Pond, the nearest surface water body, is located approximately 0.4 miles southeast of the site.

2.3.6.1 Soil Investigation

Two soil borings were hand augered in the Pest Control Area with three samples taken from each boring during August 1984. The samples were analyzed for organochlorine pesticides

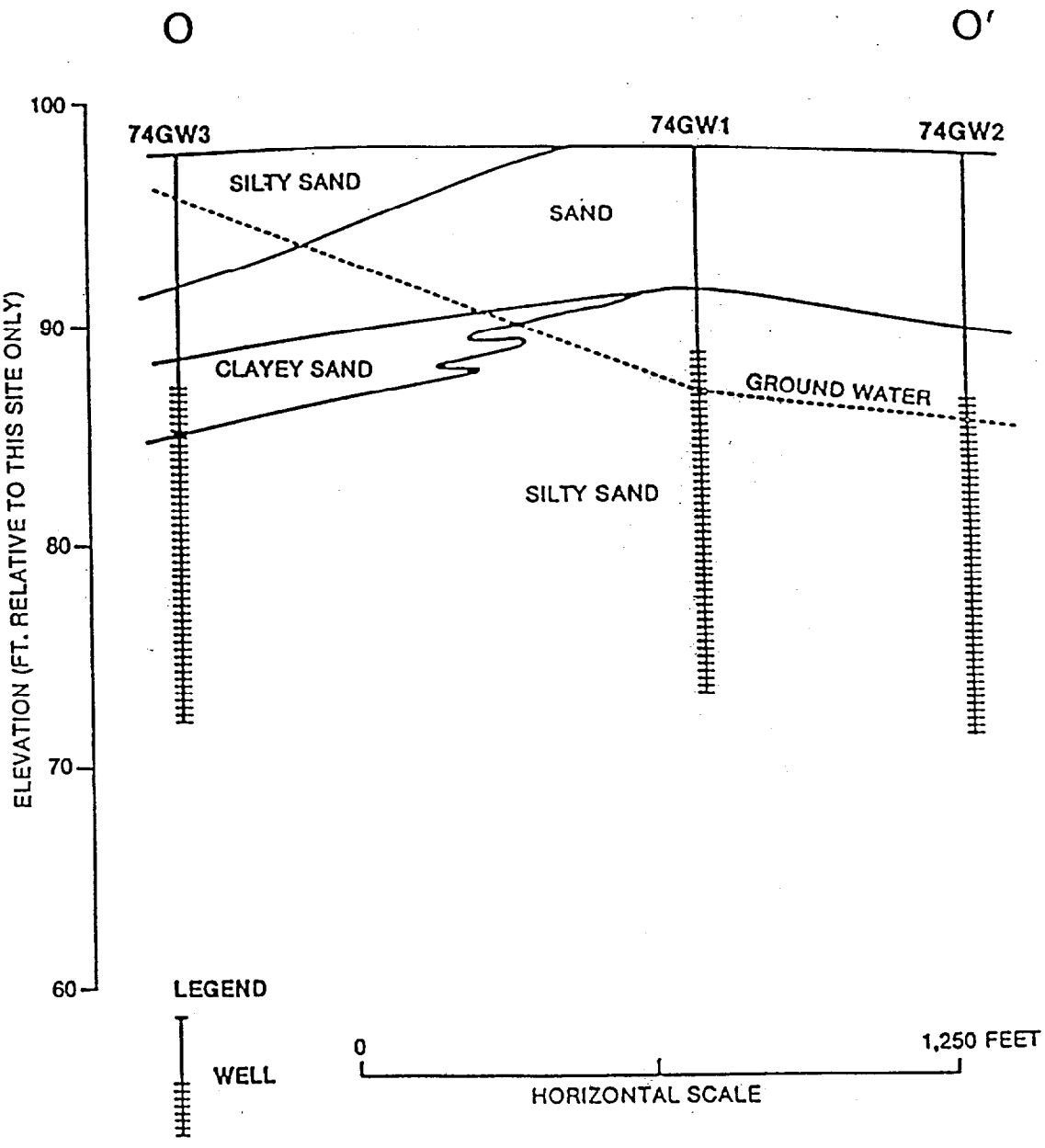

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FIGURE 2-12
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA
GEOLOGIC CROSS SECTION O-O'

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: ESE, 1991

Analytical findings indicate that DDD, DDE, and DDT were present in the soil. DDD was reported in five of the six soil samples with a maximum concentration of 0.0084 micrograms/gram (µg/g). DDE was reported in all six samples. Concentrations for DDE ranged from 0.0004 µg/g to 0.044 µg/g. DDT was reported in the three soil samples collected from soil boring 74S1. The maximum concentration reported in these samples was 0.260 µg/g. The maximum concentration of each contaminant was reported in the sample collected closest to the surface. Analytical findings are presented in Table 2-5. These values do not appear to be elevated based on levels of pesticides (e.g., typically greater than 1,000 µg/kg) detected at other pesticide storage and handling sites at MCB Camp Lejeune.

2.3.6.2 Groundwater Sampling

Three shallow monitoring wells (Figure 2-11) were installed as part of past investigations conducted at this site. Two of the wells (74GW1 and 74GW2) were installed in 1984. The third well (74GW3) was installed in 1986. Well 74GW1 is located east of the Grease Pit Disposal Area. Well 74GW2 is located southeast of the disposal area between the disposal area and Supply Well 654. Well 74GW3 is located northwest and upgradient of the disposal area; this well was installed as part of the second round of sampling conducted in 1986/1987.

The three monitoring wells were sampled during two previous sampling efforts. The first sampling effort was conducted in July 1984. The second combined effort was conducted in December 1986 and March 1987.

The groundwater samples collected during the 1984 investigation were analyzed for the following target compounds: organochlorine pesticides, chlorinated herbicides, and PCBs. Table 2-6 presents the analytical findings from the 1984, 1986, and 1987 sampling events. Only two contaminants, DDE and DDT, were detected in monitoring well 74GW2 at concentrations of 0.001 µg/L for DDE, and 0.007 µg/L for DDT.

The groundwater samples collected during the 1986/1987 investigation were analyzed for the following compounds: organochlorine pesticides, chlorinated herbicides, PCBs, tetrachlorodioxin, and volatile organics. Table 2-6 presents the analytical findings from the 1986/1987 sampling effort. Aldrin was reported, at a concentration of 0.029 µg/L, in the groundwater sample collected from monitoring well 74GW2. One positive result for methylene chloride (3.8 µg/L) was reported in monitoring well 74GW3. It is possible that this was due to laboratory or field contamination and not a true indication of the contamination at

TABLE 2-5

SITE 74 - MESS HALL GREASE PIT DISPOSAL AREA
DETECTED CONTAMINANTS IN THE SOIL
MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Sample ID/Date Sampled					
	74S1A 08/03/84	74S1B 08/03/84	74S1C 08/03/84	74S2A 08/03/84	74S2B 08/03/84	74S2C 08/03/84
DDD, 4,4'	0.0084	<0.0006	0.0006	0.0029	0.0006	0.0006
DDE, 4,4'	0.044	0.006	0.0072	0.0051	0.001	0.0004
DDT, 4,4'	0.260	0.0086	0.011	<0.0012	<0.0012	<0.0013

Values reported are concentrations in micrograms per gram (µg/g); this approximates to parts per million (ppm).

Note: There are no North Carolina pesticide soil standards.

Source: ESE, 1990.

TABLE 2-6

SITE 74 - MESS HALL GREASE PIT DISPOSAL AREA
DETECTED TARGET CONTAMINANTS IN THE GROUNDWATER (1984-1987)
MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Federal MCLs(1)	North Carolina WQS(2)	Sample ID/Date Sampled						
			74GW1 07/04/84	74GW1 12/04/86	74GW2 07/04/84	74GW2 12/04/86	74GW3 12/04/86	74GW3 03/04/87	Supply Well (654) 07/04/84
DDD, 4,4'	NS	NS	<0.0008	<0.006	<0.0008	0.029	<0.006	<0.006	<0
DDE, 4,4'	NS	NS	<0.0008	<0.006	0.001	<0.006	<0.006	<0.006	<0.006
DDT, 4,4'	NS	NS	<0.005	<0.006	0.007	<0.006	<0.006	<0.006	<0.005
Methylene Chloride	NS	5	NA	<2.8	NA	<2.8	3.8	<2.8	NA

(1) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.
(2) NCWQS - North Carolina Administrative Code, Title 15, N.C. DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA Standards.
NS = No standard established.
NA = Not analyzed.

Values reported are concentrations in micrograms per liter (µg/L).

Source: ESE, 1990.

this site; however, no information is available to assess the analytical methods employed or the Quality Assurance/Quality Control (QA/QC) protocols used in the field or laboratory and, therefore, this value is reported.

Table 2-6 presents only the analytical findings for those contaminants that were reported above the detection limit in at least one analytical sample.

2.3.5.3 Pre-Investigation Sampling and Findings

In July of 1992, groundwater samples were collected from two existing monitoring wells (74GW1 and 74GW2) to aid in characterizing current site conditions and design of this RI. The third well, 74GW3, could not be located and may have been destroyed. Repeated attempts have been made to locate this well.

Groundwater samples collected from these wells were analyzed for full TCL organics, and for total and dissolved Target Analyte List (TAL) inorganics by Contract Laboratory Program (CLP) protocols and Level IV Data Quality.

Organic contamination was not detected in the groundwater samples collected at this site. Total metals detected at this site were aluminum, barium, iron, magnesium, potassium, and sodium. Applicable standards have been established for only barium and iron. The iron concentration detected in both wells exceeded the North Carolina Water Quality Standards (NCWQS) of 300 µg/L.

The analytical findings are presented in Table 2-7.

2.3.6.4 Geophysical Investigation

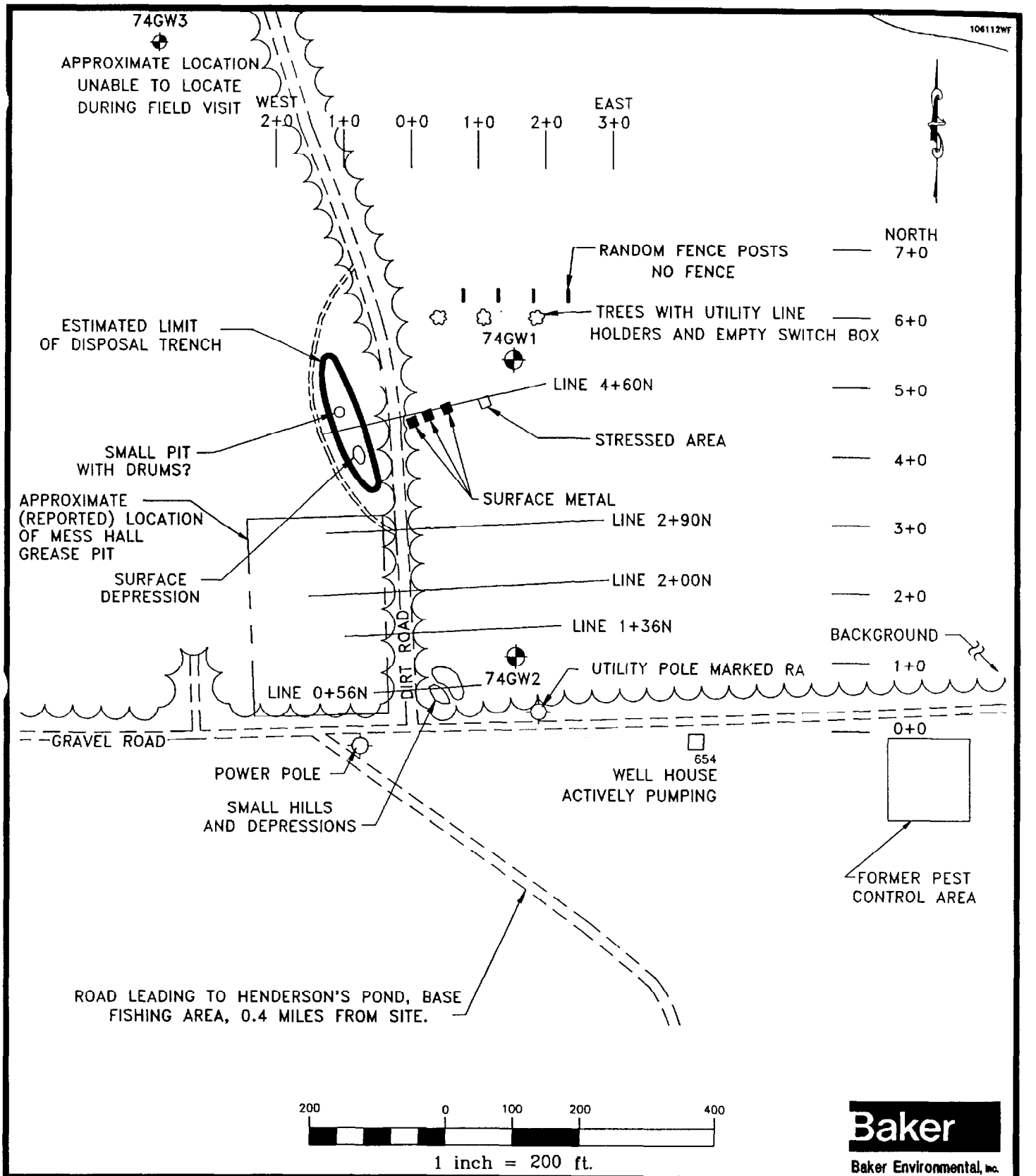
A geophysical investigation was conducted at Site 74 in July 1992. The purpose of the geophysical investigation was to delineate potential disposal areas and assist in the scoping of the RI/FS. This survey indicated a probability of subsurface disposal only near the west end of Line 4+60N (Figure 2-13). The geophysical report is provided in Appendix A.

TABLE 2-7

SITE 74 - MESS HALL GREASE PIT DISPOSAL AREA
DETECTED CONTAMINANTS IN THE GROUNDWATER (1992)
MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Federal MCLs[1]	North Carolina WQS[2]	Sample ID/Date Sampled			
			74GW1 07/07/92		74GW2 07/07/92	
			Total	Dissolved	Total	Dissolved
Aluminum	NS	NS	1,980	ND	ND	ND
Barium	2,000 (P)	1,000	28	27	32	32
Iron	NS	300	301	ND	41	ND
Magnesium	NS	NS	1,030	916	957	936
Potassium	NS	NS	923	913	605	703
Sodium	NS	NS	3,860	3,850	2,900	2,970

(1) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.
(2) NCWQS - North Carolina Administrative Code, Title 15, N.C. DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA Standards.
(P) = Proposed
ND = Not Detected at Method Detection Limit
NS = No standard established
Total/Dissolved metal concentrations
Concentrations reported in microgram per liter (µg/L)
Source: Baker Environmental, July 1992.



LEGEND

74GW1 – EXISTING SHALLOW WELL

– VEGETATION

– ROAD (UNIMPROVED)

SOURCE: WESTON GEOPHYSICAL CORP., AUGUST 1992

FIGURE 2-13
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA
RESULTS OF GEOPHYSICAL INVESTIGATION

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

2.4 Site 41 - Camp Geiger Dump Near Former Trailer Park

This section describes the location, setting, and history of Site 41. In addition, previous site investigation activities are summarized in Section 2.4.6.

2.4.1 Site Location and Setting

Site 41, Camp Geiger Dump Near Former Trailer Park, is located in the Camp Geiger area of MCB Camp Lejeune (see Figure 2-1). The site is situated east of U.S. Highway 17, south of the former Camp Geiger trailer park, west of an unnamed tributary, and north of Tank Creek. The unnamed tributary and Tank Creek flow into Southwest Creek east of the site. Southwest Creek discharges into the New River approximately 3 miles downstream of this confluence.

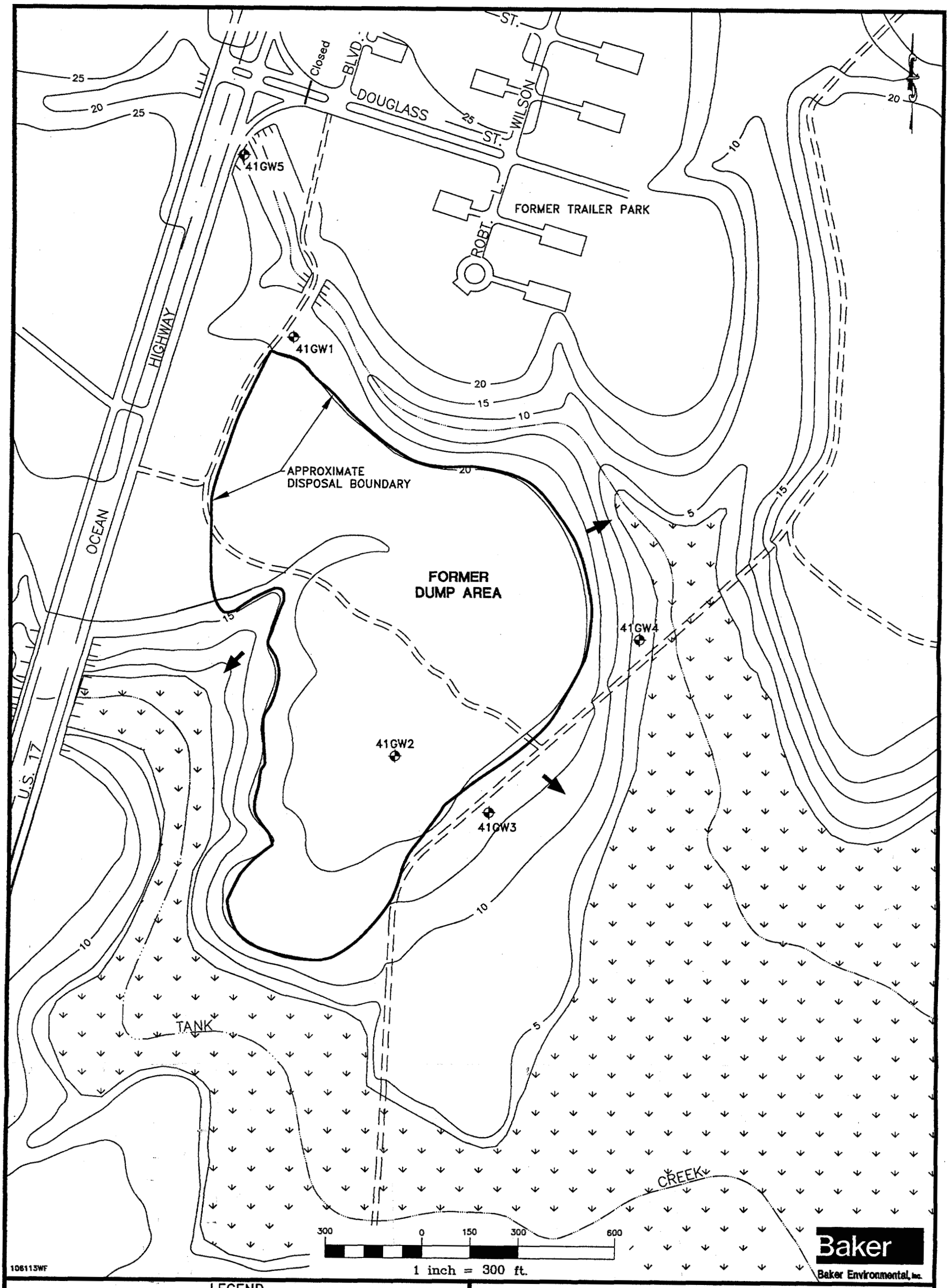
The area is heavily wooded and vegetated. The physical boundary of the former disposal area is barely discernible. Dirt roads are present along the boundary and through the center of the site. Some portions of these roads are overgrown and impassible due to ponding. The area of the former dump is estimated to be approximately 30 acres (Water & Air Research, 1983). Aerial photographs of the site confirm this estimation.

The areas along the eastern and southern boundaries are classified as wooded wetlands. These areas are downslope of the former disposal area. Signs of beaver, deer, and sightings of black snakes, frogs, and turtles were observed during a site reconnaissance conducted as part of the preparation of RI/FS Project Plans.

Throughout the former disposal area are piles of construction debris, mainly metal and concrete. Drums of various sizes (i.e., 5 gallons up to 55 gallons) were noted during the site reconnaissance throughout the disposal area at "random" locations (e.g., one drum or canister was observed at various areas throughout the site). Most of the drums were rusted and unidentifiable. However, one 10-gallon empty canister was labeled "Dry Cleaning Solvent." There were no areas where more than one or two drums were noted on the ground surface.

2.4.2 Topography and Surface Drainage

The former dump is situated at a local topographic high area with an elevation of approximately 20 feet msl (see Figure 2-14). This portion of the study area is relatively flat. With the exception of the northwest portion of the study area, which is relatively flat, the area



LEGEND

41GW1 – EXISTING GROUNDWATER MONITORING WELL

– ESTIMATED DIRECTION OF SHALLOW GROUNDWATER FLOW

– MARSH

5 – TOPOGRAPHIC ELEVATION LINES

– ROAD (IMPROVED)

– ROAD (UNIMPROVED)

– INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 2–14
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
GENERAL ARRANGEMENT MAP
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02317S03Z

surrounding the former dump is comprised of moderate to steep hillsides which slope toward the unnamed tributary to the north and east, and to Tank Creek to the south and southwest.

Soils identified by the Soil Conservation Service survey (USDA, 1984) identified excavated soils at Site 41. The occurrence of excavated soils at Site 41 would tend to confirm past disposal activities. Excavated soils are typically poorly drained and lack vertical layering. Surface waters are subject to ponding during the wet seasons of the year. Ponding was observed along old roadways throughout the site.

2.4.3 Site History

Site 41 was used as an open burn dump from 1946 to 1970. The dump received construction debris and several types of wastes including: petroleum, oil, and lubricants (POL); solvents; batteries; mirex in bags; and ordnance including thousands of mortar shells, one case of grenades, and one 105mm Howitzer shell. In addition, it is reported that in the mid-1960s, at least two waste disposal incidents occurred involving the disposal of drummed wastes from trucks. At such times, a fire truck was present. These wastes were described as being similar to the types of wastes disposed of at Site 69 (Rifle Range Chemical Dump). More definitive information is not available to properly identify these wastes. However, it is known that drums of chemical training agents, which may contain small quantities of blister agents, were disposed of at Site 69. In addition, an incident occurred at Site 69 involving the explosion of containers containing HTH.

2.4.4 Site Geology and Hydrogeology

Previous investigations conducted at Site 41 involved the installation of five shallow monitoring wells and the collection of static water levels. The description of the geology and hydrogeology given below was taken from the Final Site Summary Report for MCB Camp Lejeune (ESE, 1990). Boring logs or monitoring well construction diagrams associated with the study are not available.

The site is underlain primarily by silty sand, with discontinuous layers of shelly sand, silty-clayey sand, silt, and clay. The surface of the shallow groundwater lies within the silty sand at depths ranging from 2.56 to 10.75 feet bgs. (ESE, 1990). The geology and hydrogeology of the site is depicted on Figure 2-15 (Geologic Cross Section - Site 41). Groundwater flow was reported to be southeast toward Tank Creek and the unnamed tributary. No information was

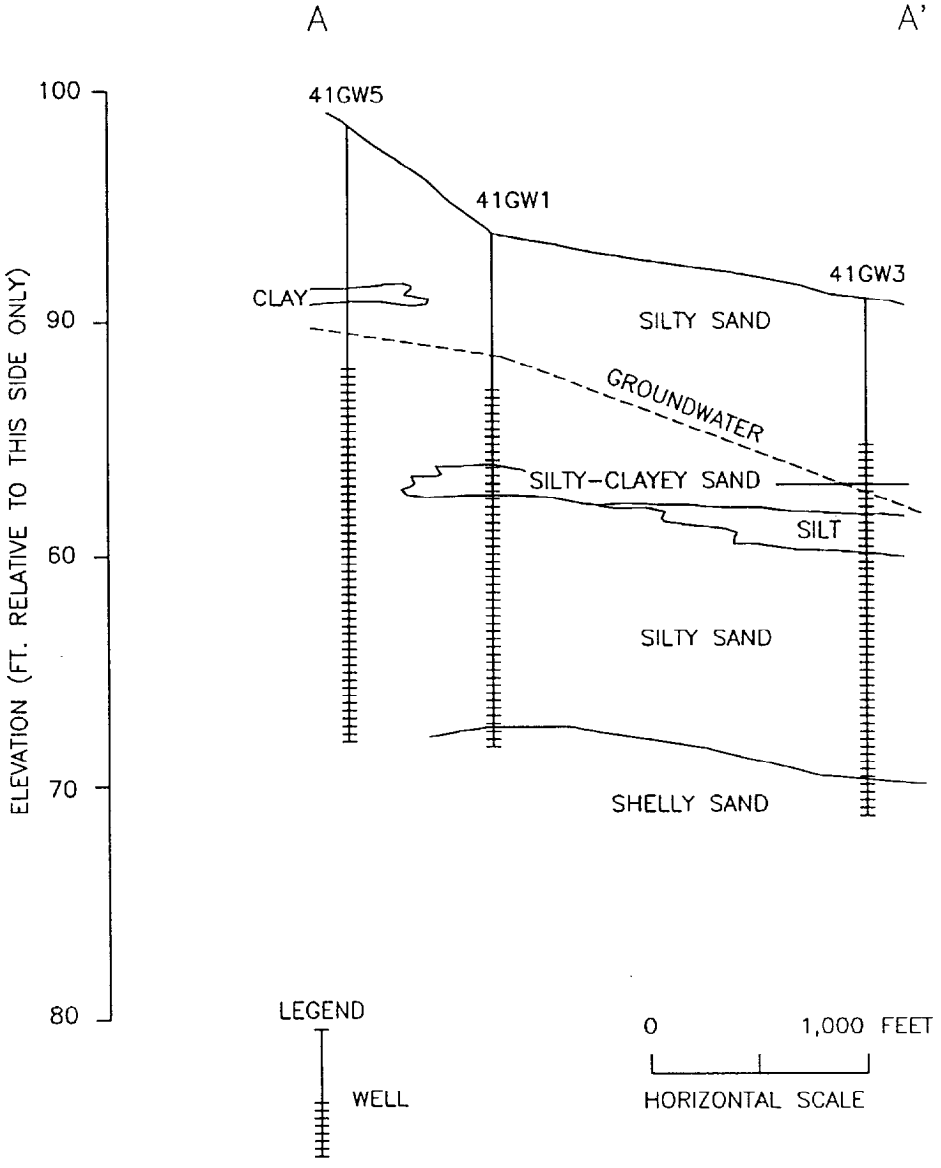


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FIGURE 2-15
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
GEOLOGIC CROSS SECTION A-A'
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: ESE, 1990

provided with respect to the number of static water level measurements obtained to determine flow direction. Based on the topography of the area, shallow groundwater may flow radially from the site.

2.4.5 Site 41 Land Use and Demographics

The area encompassing Site 41 is occasionally used for military training exercises. The site is not fenced; therefore, access is not restricted from within the base or U.S. Highway 17. The closest military complex is Camp Geiger, located approximately two miles northeast of the site (see Section 2.1.9 for a description of Camp Geiger). Future land use of the area is reserved for military training. Hunting is permitted in the area via permission from the base command.

The area downslope of the site is a wooded wetland. There may be sensitive ecological receptors in this area. This will be further evaluated as part of the ecological risk assessment.

2.4.6 Previous Investigations and Findings

This section summarizes the results of previous investigations conducted at Site 41. These investigations were limited to groundwater and surface water/sediment.

2.4.6.1 Groundwater Investigations

Four shallow monitoring wells were installed as part of the Verification Step in 1984 and one shallow monitoring well was installed in 1986 as part of the Characterization Step. The well locations are depicted on Figure 2-14.

The depths of the wells are approximately 20 to 25 feet bgs, based on information given in Figure 2-15. As mentioned previously, no well logs or well construction diagrams are available for review. Well 41GW1 is located in an apparent upgradient location near the northwest corner of the former dump. Well 41GW2 is located near the center of the former disposal area. Wells 41GW3 and 41GW4 are located along the eastern boundary of the disposal area. An upgradient well, 41GW5, was installed in 1986 along U.S. Highway 17 northwest of the site. Groundwater samples were collected in 1984 and in 1987. The samples were analyzed for the following compounds:

- Cadmium
- Chromium
- Hexavalent chromium (1987 only)
- Lead
- VOCs
- Total phenols
- Organochloride pesticides (OCP)
- Oil and grease
- Mirex
- Ordnance compounds (not defined)
- Tetrachlorodioxin (1987 only)
- Xylene (1987 only)
- MEK (1987 only)
- MIBK (1987 only)

Analytical methods were not available. The results are summarized on Table 2-8.

Elevated levels of chromium above State and Federal standards were detected in four of the five monitoring wells, well 41GW4 was below the standards. Note that the second highest detection of chromium was detected in the upgradient monitoring well (41GW5). Lead was detected above State or Federal standards in at least three of the five wells (wells 41GW1, 41GW2 and 41GW3). Lead was reported below the detection level in wells 41GW4 and 41GW5; however, the detection level was above the Federal action level of 15 µg/L.

Low levels of phenols were detected in all five wells. Dichlorodifluoromethane and vinyl chloride were detected just above State standards in well 41GW2. Trace levels of benzene were also detected in this well.

A single detection of RDX (cyclotrimethylenetrinitramine), a compound associated with explosives, was detected in well 41GW3. This indicates that groundwater may have been impacted by the disposal of ordnance.

Overall, the degree of groundwater contamination detected in the existing wells is low. The elevated metals may be due to improper sampling techniques or well construction given that the upgradient sample exhibited some metal contamination. This will be evaluated during the RI.

2.4.6.2 Surface Water/Sediment Investigation

Four surface water and sediment samples were collected in 1987; two from Tank Creek and two from the unnamed tributary (see Figure 2-16). The surface water samples were analyzed for the same parameters as groundwater. Sediment samples were analyzed for the following compounds:

TABLE 2-8

SITE 41 - CAMP GEIGER DUMP NEAR FORMER TRAILER PARK
DETECTED CONTAMINANTS IN GROUNDWATER SAMPLES
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Federal MCLs[1]	North Carolina WQS[2]	Sample ID/Date Sampled									
			41GW1 7/16/84	41GW1 1/8/87	41GW2 7/16/84	41GW2 1/8/87	41GW3 7/16/84	41GW3 1/13/87	41GW4 7/16/84	41GW4 1/13/87	41GW5 1/13/87	41GW5 3/5/87
Benzene	5	1	<0.3	<1	0.3	<1	<0.3	<1	<0.3	<1	<1	<1
Dichlorodifluoromethane	NS	0.19	<1	<10	8	<10	<1	<10	<1	<10	<10	<10
trans-1,2-Dichloroethene	100	70	<1	<1.6	1.1	<1.6	<1.1	<1.6	<1.1	<1.6	<1.6	<1.6
Vinyl chloride	2	0.015	<0.7	<1	1	<1	<0.9	<1	<0.9	<1	<1	<1
Aldrin	NS	NS	<0.0008	<0.013	<0.0008	0.017	<0.0008	<0.013	<0.0008	<0.013	<0.013	<0.006
Heptachlor	0.40	0.076	<0.0007	<0.013	<0.0007	<0.013	<0.0007	<0.013	<0.0007	<0.013	<0.013	0.007
Cadmium	NS	5	<6	<2.9	<6	<2.9	7.1	<2.9	<6	<2.9	4	<3.5
Chromium	100	50	76	10	530	43	230	28	32	<9.4	117	17
Lead	15*	50	74.6	<27	196.3	52	119.4	<27	<40	<27	<27	<27
Oil and Grease	NS	NS	2,000	1,000	2,000	1,000	2,000	900	48,000	2,000	1,000	3,000
Phenols	NS	NS	<1	11	4	11	1	<2	2	6	18	<2
RDX	NS	NS	<3.42	<0.745	<3.23	<7.45	<3.3	1.28	<3.3	<0.745	<0.745	<0.745

(1) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.

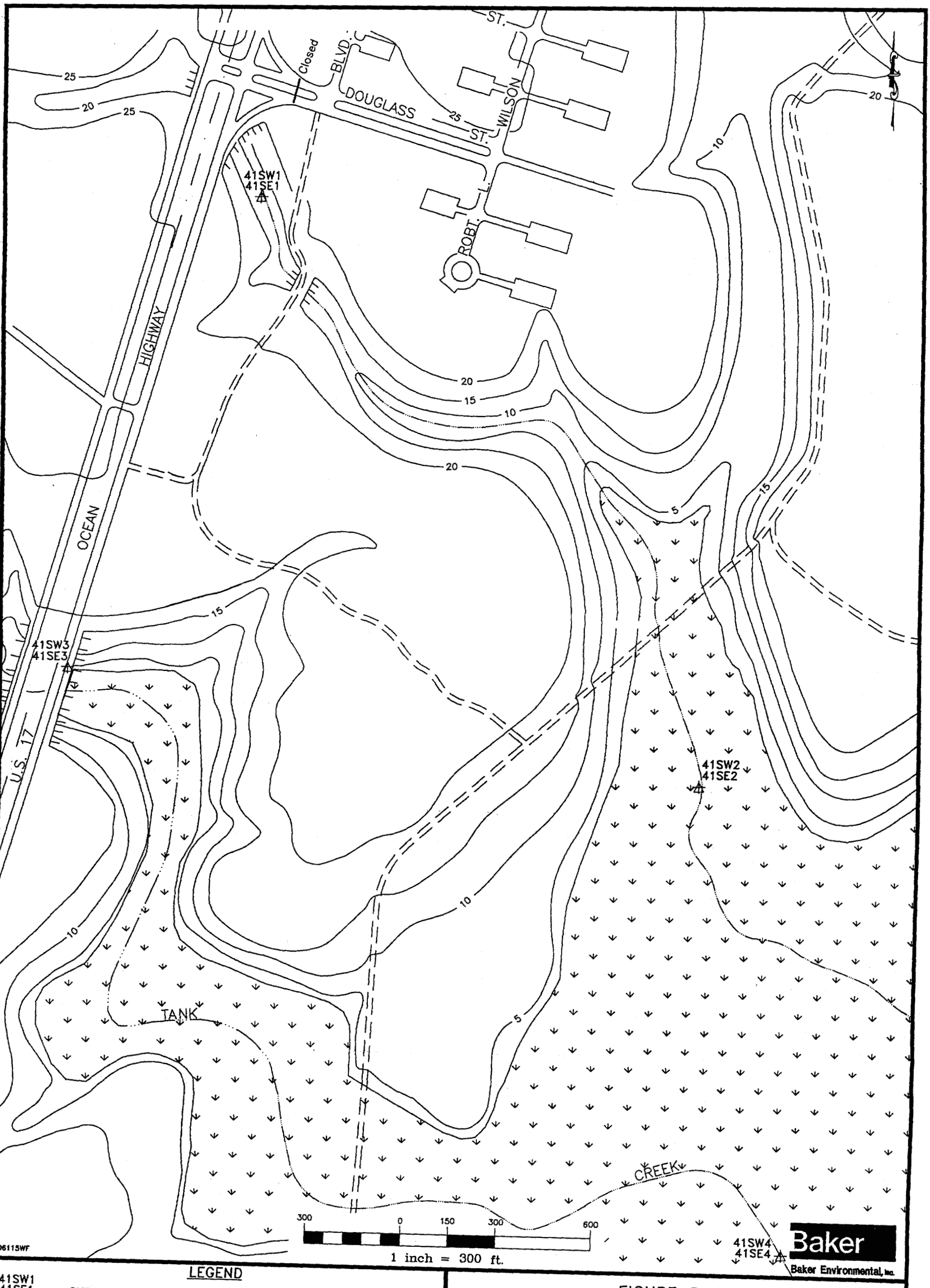
(2) NCWQS - North Carolina Administrative Code, Title 15, N.C. DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA standards.

NS = No standard established

* Standard is an action level

Values reported are concentrations in micrograms per liter (µg/L); this approximates parts per billion (ppb).

Source: ESE, 1990.



LEGEND

41SW1 41SE1 – SURFACE WATER/SEDIMENT SAMPLING LOCATION

– MARSH

5 – TOPOGRAPHIC ELEVATION LINES

– ROAD (IMPROVED)

– ROAD (UNIMPROVED)

– INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 2–16
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
PREVIOUS SURFACE WATER SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02317S047

- Cadmium
- Chromium
- Lead
- Hexavalent chromium
- Oil and Grease
- Total Phenols
- Mirex
- OCP
- Tetrachlorodioxin (TCDD)
- Ordnance

The detected analytes in surface water and sediment are presented on Tables 2-9 and 2-10, respectively.

Oil and grease and phenols were detected in all four surface water samples. Aldrin was detected at three of the four sampling stations, it was not detected at 41SW1. The pesticide deltaBHC or hexachlorocyclohexane (BHC,D) was detected at station 41SW2.

Sediment samples revealed low levels of total chromium, hexavalent chromium, lead, O&G, and phenols. In addition, both samples from Tank Creek revealed the explosive constituent trinitrotochene (2,4,6-TNT).

Overall, surface water and sediments may be impacted by the former disposal activities at Site 41.

TABLE 2-9

SITE 41 - CAMP GEIGER DUMP NEAR FORMER TRAILER PARK DETECTED CONTAMINANTS IN SURFACE WATER SAMPLES MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Federal Ambient Water Quality Criteria		North Carolina Surface Water Standards	Sample ID/Date Sampled			
	Organisms(1)	Health(2)		41SW1 1/8/87	41SW2 1/8/87	41SW3 1/8/87	41SW4 1/8/87
Oil and Grease	NS	NS	NS	1,000	500	200	300
Phenols	2,560(3)	3,500	1	4	7	6	10
Aldrin	NS	0.000074	0.002	<0.013	0.013	0.015	0.014
delta-BHC	NS	NS	NS	<0.026	0.047	<0.026	<0.026
Methylene chloride	NS	NS	NS	8.7	5.5	9.7	6.8

(1) Freshwater Chronic Criteria
(2) Protection of Human Health - Water and Organisms.
(3) Insufficient data to develop criteria value presented in the LOEL.
NS = No standard established

Values reported are concentrations in micrograms per liter (µg/L); this approximates parts per billion (ppb).

Source: ESE, 1990.

TABLE 2-10

SITE 41 - CAMP GEIGER DUMP NEAR FORMER TRAILER PARK
DETECTED CONTAMINANTS IN SEDIMENT SAMPLES
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Sample ID/Date Sampled			
	41SE1 1/8/87	41SE2 1/8/87	41SE3 1/8/87	41SE4 1/8/87
Chromium	2.66	1.77	1.86	5.09
Chromium (+6)	<1.31	1.36	1.57	3.74
Lead	12.1	4.89	<3.49	<4.63
Oil and Grease	208	111	40	159
Phenols	<0.066	<0.066	0.081	0.118
2,4,6-TNT	<0.00341	<0.00345	0.00459	0.357

Values reported are concentrations in micrograms per gram (µg/g); this approximates parts per million (ppm).

Source: ESE, 1990.

3.0 EVALUATION OF EXISTING INFORMATION

This section describes the types and volume of known wastes at each site, potential migration and exposure pathways, preliminary public health and environmental impacts, preliminary ARARs applicable to the sites, potential remedial technologies, and data limitations. This summary of information will be used to identify the RI/FS objectives (Section 4.0).

3.1 Site 69 - Rifle Range Chemical Dump

3.1.1 Types and Volumes of Waste Present

According to documented information in site reports approximately 93,000 cubic yards of hazardous material may have been disposed at Site 69, based on an area of approximately six acres and an assumed depth of 10 feet (Water and Air Research, 1983). The hazardous materials include pentachlorophenol, various pesticides (e.g., DDT, malathion, diazinon, lindane), TCE, PCBs, fire retardants, chemical agent test kits, gas cylinders, and rifle cartridges. In addition, approximately 50 drums containing training agents are reported to be buried at the site. These materials were disposed in pits or trenches ranging from 6 feet to 20 feet deep (Water and Air Research, 1983). There have been no individual volume estimates made for each type of material disposed at the site.

As previously discussed in Section 2.2, several areas of suspected disposal activities were observed at Site 69 during Baker's site reconnaissance: two areas of stained soils, a chemical agent test kit (M256) disposal area, a long trench, and a formerly open area. The chemical agent test kits were the only items on the list of disposed materials that were observed during the September 1991 site reconnaissance.

Based on the analytical data collected from the site, VOCs and various inorganics are present in the groundwater and surface water at the site. Pesticides and pentachlorophenol may be contained in sediments. No soil sampling had been conducted in previous investigations.

3.1.2 Potential Migration and Exposure Pathways

Based on the evaluation of existing conditions at Site 69, the following potential contaminant migration and exposure pathways have been identified:

Migration Pathways

- Overland surface soil runoff to drainage ditches.
- Leaching of wastes through drums to subsurface soil.
- Migration of buried wastes to surface soil via volatilization or leachate.
- Migration of contaminants in subsurface soil to groundwater.
- Groundwater discharge to nearby drainage ditches/springs or streams (i.e., unnamed tributary to the New River, Everett Creek, and New River).
- Contaminate infiltration from shallow aquifer to the deep aquifer.

Exposure Pathways

- Wildlife (e.g., deer and other mammals) exposure due to dermal contact or incidental ingestion of surface and subsurface soil, and surface water.

- Human exposure by military personnel working inside the area due to dermal contact or incidental ingestion of surface soil and standing water (currently access to the area is restricted by a fence).

- Human exposure by military personnel outside the fenced area due to dermal contact or incidental ingestion of surface soil and standing water, as a result of runoff from the site.

- Human exposure by military personnel due to dermal contact or incidental soil ingestion which could occur during training/maneuvers, future construction, or future residence. (currently, access to the area is restricted by a fence).

- Human exposure due to dermal contact with groundwater or groundwater ingestion for a future residential scenario. (Presently, groundwater in this area is not used as a potable water supply).

3.1.3 Preliminary Public Health and Environmental Health Impacts

A preliminary risk evaluation of Site 69 has concluded that there may be potential human and ecological risk to receptors due to the contamination detected at this site. Military personnel have been identified as the probable human receptors. The non-human population of receptors

includes, but is not limited to, small mammals such as raccoon and fox, deer, birds, reptiles, and aquatic organisms, such as fish.

3.1.4 Preliminary Identification of ARARs

3.1.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted for Site 69, it appears that the contaminated media include groundwater (VOCs and inorganics), surface water (VOCs and inorganics), and sediments (pesticides, inorganics, and pentachlorophenol). Possible chemical-specific ARARs related to the remediation of these contaminated media may include: NCWQS for groundwater, and North Carolina Surface Water Standards for surface water and Federal Maximum Contaminate Levels (MCLs) and ambient water quality criteria (AWQC). There are no North Carolina or Federal ARARs for soil or sediment; however, USEPA Region IV's "Water Quality and Sediment Screening Values" will be used as a "To Be Considered" (TBC) ARAR when evaluating ecological impacts in surface waters and sediment.

Table 3-1 compares the maximum concentrations of compounds detected in the groundwater at Site 69 with the NCWQS and the Federal MCLs. As shown on the table, compounds that exceed the established standards include benzene, chloroform, 1,2-dichloroethane, methylene chloride, tetrachloroethene, trans-1,2-dichloroethene, TCE, vinyl chloride, iron, lead, manganese, and zinc. As shown on Table 3-2, maximum detected mercury, zinc, and cyanide concentrations exceed the North Carolina surface water standards, while benzene, chlorobenzene, 1,2-dichloroethene, ethylbenzene, toluene, trans-1,2-dichloroethene, trichloroethene, pentachlorophenol, mercury, zinc, and cyanide exceed the AWQC.

3.1.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of activities in wetlands, floodplains, and historical sites. It is not believed that these ARARs would be applicable to remedial activities within the site boundary.

TABLE 3-1

SITE 69 - RIFLE RANGE CHEMICAL DUMP
COMPARISON OF CHEMICAL-SPECIFIC ARARs WITH
CONTAMINANTS DETECTED IN GROUNDWATER
MCB CAMP LEJEUNE, NORTH CAROLINA

Chemical	North Carolina WQS[2] (µg/L)	Federal MCLs[3] (µg/L)	Maximum Concentrations Detected in Groundwater Samples (µg/L)[4]
VOLATILES:			
Acetone	NS	NS	15
Benzene	1	5	4
Carbon Disulfide	NS	NS	9
Chlorobenzene	300	100	55
Chloroform	0.19	100	14
Chloromethane	NS	NS	16
1,2-Dibromoethane	NS	NS	4.74
1,2-Dichloroethane	0.38	5	5.9
1,1-Dichloroethylene	7	7	2.7
cis-1,2-Dichloroethene	70	70	220
Methylene Chloride	5	5	10
1,1,2,2-Tetrachloroethane	NS	NS	44
Tetrachloroethene	0.7	5	20
Toluene	1000	1000	14
trans-1,2-Dichloroethene	70	100	37,000
Trichloroethene	2.8	5	710
Vinyl Chloride	0.015	2	440
PESTICIDES:			
alpha-BHC	NS	NS	1.2
delta-BHC	NS	NS	0.067
delta-BHC	NS	NS	2.44

TABLE 3-1 (Continued)

SITE 69 - RIFLE RANGE CHEMICAL DUMP
COMPARISON OF CHEMICAL-SPECIFIC ARARs WITH
CONTAMINANTS DETECTED IN GROUNDWATER
MCB CAMP LEJEUNE, NORTH CAROLINA

Chemical	North Carolina WQS(2) (µg/L)	Federal MCLs(3) (µg/L)	Maximum Concentrations Detected in Groundwater Samples (µg/L)(4)
INORGANICS:			
Arsenic	50	50	11.4
Chromium	50	100	47.6
Copper	1000	1300(6)	27.5
Iron	300	300(6)	792,000
Lead	50	15(5)	23.9
Manganese	50	50(6)	230
Mercury	1.1	2	0.2
Silver	50	100(6)	13.9
Zinc	5000	5000(6)	10200
Cyanide	154	200	11.2

(1) Abbreviations:
NS = No standard established.
ND = Not detected.
NCWQS = North Carolina Water Quality Standards.

(2) NCWQS. North Carolina Administrative Code, Title 15, NC DEHNR, Subchapter 2L, Section .0202 - Water Quality Standards for Groundwater, August 4, 1989. Class GA Standards.

(3) Federal Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act of 1986.

(4) Maximum concentrations listed do not include concentrations detected in blanks, estimated concentrations, or those concentrations detected below the method detection limit.

(5) MCL is Action Level for Public Water Supply Systems, effective 11/06/91.

(6) MCLG is Maximum Contaminant Level Goal.

TABLE 3-2

SITE 69 - RIFLE RANGE CHEMICAL DUMP
COMPARISON OF CHEMICAL-SPECIFIC ARARs WITH
CONTAMINANTS DETECTED IN SURFACE WATER SAMPLES
MCB CAMP LEJEUNE, NORTH CAROLINA

Chemical	North Carolina Surface[2] Water Standards (µg/L)	Ambient Water Quality Criteria[3] (µg/L)		Maximum Concentrations Detected in Surface Water Samples (µg/L)[4]
		Acute	Chronic	
VOLATILES:				
Acetone	NS[1]	NS	NS	22
Benzene	NS	5,300	NS	0.4
Carbon Disulfide	NS	NS	NS	28
Chlorobenzene	NS	NS	NS	2.1
Chloroform	NS	28,900	1,240	6
1,2-Dichloroethane	NS	118,000	20,000	0.9
1,2-Dichloroethene	NS	NS	NS	190
Ethylbenzene	NS	32,000	NS	3
Methylene Chloride	NS	NS	NS	8
1,1,2,2-Tetrachloroethane	NS	NS	2,400	59
Toluene	NS	17,500	NS	11
trans-1,2-Dichloroethene	NS	NS	NS	410
Trichloroethene	NS	45,000	21,900	63
Vinyl Chloride	NS	NS	NS	41
SEMIVOLATILES:				
Pentachlorophenol	NS	20	13	10
PESTICIDES:				
alpha-BHC	NS	NS	NS	0.056
beta-BHC	NS	NS	NS	0.18
delta-BHC	NS	NS	NS	0.2

TABLE 3-2 (Continued)

SITE 69 - RIFLE RANGE CHEMICAL DUMP
COMPARISON OF CHEMICAL-SPECIFIC ARARs WITH
CONTAMINANTS DETECTED IN SURFACE WATER SAMPLES
MCB CAMP LEJEUNE, NORTH CAROLINA

Chemical	North Carolina Surface[2] Water Standards (µg/L)	Ambient Water Quality Criteria[3] (µg/L)		Maximum Concentrations Detected in Surface Water Samples (µg/L)[4]
		Acute	Chronic	
INORGANICS:				
Iron	1000[5]	NS	1000	4420
Magnesium	NS	NS	NS	753,000
Manganese	NS	NS	NS	223
Mercury	0.012	2.4	0.012	0.2
Zinc	50[5]	120	110	1960
Cyanide	5.0	22	5.2	11.2

(1) Abbreviations:
NS = No standard established.

(2) North Carolina Administrative Code, Title 15, NC DEHNR, Subchapter 2B, Section .0212 - Freshwater Classifications and Standards. December 12, 1989. For Protection of Aquatic Life.

(3) Ambient Water Quality Criteria pursuant to the Clean Water Act.

(4) Maximum concentrations listed do not include concentrations detected in blanks, estimated concentrations, or those concentrations detected below the method detection limit.

(5) Action level.

3.1.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for Site 69 will be identified when potential remedial action technologies have been selected.

3.1.5 Potential Remedial Technologies/Alternatives

The purpose of this section is to identify potential remedial technologies for each affected medium in order to identify what data may be necessary to evaluate technologies during the Feasibility Study.

3.1.5.1 Soil

No soil sampling has been conducted at this site. Based on the limited knowledge of what was actually disposed, potential remedial technologies cannot be identified at this time. This is primarily due to the fact that it is not known if wastes have been mixed together during burial. The presence of mixed wastes (e.g., pesticides with volatiles) will have an impact on the selection and combining of technologies to form remedial alternatives. Additionally, because chemical agents are actually present, no remedial action is allowable under current U.S. Army direction. Therefore, soil samples for subsequent treatability studies or engineering analysis will not be collected as part of this initial RI sampling program.

3.1.5.2 Sediment

Previous studies have identified the presence of low levels of pesticides, inorganics, and pentachlorophenol. Several technologies potentially capable of treating these pesticides and semivolatiles include thermal destruction (i.e., incineration), chemical extraction, soil washing, stabilization/fixation, dechlorination for pesticides only, and biodegradation. Technologies for remediation of inorganics include soil washing and stabilization. These technologies have been preliminarily identified as potentially feasible, based on the limited amount of information available. This listing will be refined as the RI/FS progresses.

Each of the potentially feasible technologies will require specific data in order to evaluate their effectiveness, implementability, and cost.

3.1.5.3 Groundwater

Previous investigations have detected the presence of volatile and inorganic contaminants in the shallow aquifer. A number of technologies have been identified as potentially feasible including pumping, containment via extraction wells, air stripping, carbon adsorption, ultraviolet (UV)/ozone oxidation, and in-situ chemical treatment.

These technologies have been preliminarily identified as potentially feasible, based on the limited amount of information available. This listing will be refined as the RI/FS progresses.

Each of the potentially feasible technologies will require specific data in order to evaluate their effectiveness, implementability, and cost.

3.1.6 Data Limitations

The purpose of this section is to define data limitations with respect to either characterizing the site, assessing human health and environmental risks, or evaluating potential feasible technologies. The analytical methods and the level of QA/QC used for the analyses of the data provided for review were not included in the background information received for this site, and, therefore, could not be reported in this Work Plan. Consequently, the data provided are not suitable to fully characterize the site or to make an assessment of human health or ecological risks. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4.1 of this RI/FS Work Plan.

3.1.6.1 Wastes and Debris

The types of wastes disposed of at the site are known; however, the method of disposal (e.g., drum disposal, surface spills, bulk disposal of liquids or solids into trenches) is not entirely known with the exception of how PCB oils and chemical agents were disposed of (i.e., in drums). It is not known how solvents were disposed of at Site 69 (i.e., in drums or surface spills).

The actual disposal areas have been preliminarily identified through geophysical investigations, site reconnaissances, and review of aerial photographs. However, it is unknown whether drums of wastes containing chemical agents were buried in the same

trenches as drums of other wastes such as PCB transformer oils or pesticides. Wastes were reportedly disposed of in trenches between 6 and 20 feet in depth and up to 75 feet in length.

3.1.6.2 Soil

No soil sampling has been conducted to date. The type of surface and subsurface contamination due to past disposal practices is unknown. Information is not available to assess potential migration to groundwater, impacts to human health, the ecology, or potential off-site migration due to surface runoff.

3.1.6.3 Sediment

Existing data have identified the presence of pesticides and pentachlorophenol in the sediments of the two unnamed tributaries. Additional analytical data will be needed to characterize sediment contamination and delineate areas of concern. In addition, human health and ecological risks due to contaminated sediments at Site 69 need to be assessed.

3.1.6.4 Groundwater

Elevated levels of VOCs and low levels of inorganic contaminants have been detected in groundwater. The wells installed to date are all located near the former disposal area. Off-site groundwater quality is unknown. Groundwater flow directions need to be further evaluated since at least one groundwater divide has been identified by previous investigations. The hydrogeologic characteristics (e.g., transmissivity and storativity) are also unknown. Future potential human health and ecological risks need to be assessed.

3.1.6.5 Surface Water

VOCs and metals were detected in on-site surface water (standing pools of water) at Site 69. Surface water samples were collected from Everett Creek and the unnamed tributary to the north of the site. In addition, samples were collected from the New River. Overall, surface waters in drainage areas (springs, seeps) have not been fully characterized.

3.1.6.6 Aquatic Life

Tissues from oysters and mussels in the New River were collected and analyzed during a previous investigation (ESE, 1991). Two volatile contaminants (acetone and chloromethane) and low levels of inorganics were detected in the samples. No background samples (upgradient) samples were collected for comparison. Because no sediment or surface water samples collected from the New River exhibited VOC contamination, the presence of volatiles may not be attributable to the site. Further evaluation of aquatic life in the New River has been conducted, along with an evaluation of present day surface water and sediment conditions (conducted by Baker in August 1992). The results of this study will be used to assess human health and ecological risks.

3.2 Site 74 - Mess Hall Grease Pit Disposal Area

3.2.1 Types and Volumes of Waste Present

Only limited information is available regarding the former disposal activities at the site. The former grease pit is reportedly 100 to 135 feet long by 30 feet wide by 10 to 12 feet deep. The pest control area is reported to be 100 feet by 100 feet (ESE, 1990). Four other trenches near the grease pit have been identified.

Pesticide contamination from pest control activities could have resulted from dripping sawdust bags, small spills, washout and excess disposal. It has been estimated that at least several gallons per year were released. Therefore, over about 10 years, the quantity involved is estimated on the order of 50 to 500 gallons (Water and Air Research, 1983).

One or more truckloads of pesticides in 55-gallon drums were disposed of at this site. Assuming two truck loads of 20 full drums each, a quantity of 2,200 gallons of pesticides was buried here, most likely in trenches near the grease pit. Approximately 20 drums of PCB containing transformer oil, or 1,100 gallons, are reportedly buried on site (Water and Air Research, 1983).

It has also been reported (Water and Air Research, 1983) that drums from Site 69 (Rifle Range Chemical Dump) have been buried at Site 74. Site 69 was used as a landfill for chemical agents. Drums containing chemical agents, therefore, may have been disposed at Site 74. The quantity and contents of these drums are unknown.

In general, further evaluation is needed to determine the extent of soil and groundwater contamination associated with previous disposal activities.

3.2.2 Potential Migration and Exposure Pathways

Based on the evaluation of existing conditions at Site 74, the following potential contaminant migration and exposure pathways have been identified:

Migration Pathways

- Overland surface soil runoff from Site 74.
- Leaching of contaminants from buried waste (e.g., drums, bags) into subsurface soil.
- Migration of contaminants in subsurface soil to groundwater.
- Groundwater discharge to surface water.
- Groundwater infiltration from the shallow aquifer to the deeper aquifer.

Exposure Pathways

- Wildlife exposure due to dermal contact or incidental soil ingestion.
- Wildlife (e.g., burrowing animals) exposure due to dermal contact to contaminants in subsurface soil.
- Human exposure due to incidental soil ingestion or dermal contact.
- Human exposure due to future potential dermal contact with soil.
- Human exposure due to future potential dermal contact with groundwater.
- Human exposure due to future potential groundwater ingestion.
- Future potential human exposure due to ingestion of contaminated wildlife.

3.2.3 Preliminary Public Health and Environmental Health Impacts

There may be potential human risk to receptors due to the contamination detected at the site. Military personnel who train in the area or who may use the area for hunting have been identified as the probable human receptors. The nonhuman population of receptors includes, but is not limited to, small mammals such as raccoon and fox, deer, birds, and reptiles which could potentially be exposed to surficial or subsurface contamination.

3.2.4 Preliminary Identification of ARARs

3.2.4.1 Chemical-Specific ARARs

Based on the analytical results from the previous sampling activities conducted at Site 74, it appears that the contaminated media include soil and groundwater. Chemical-specific ARARs that may be applicable to Site 74 include the NCWQS, and Federal MCLs established under the Safe Drinking Water Act and AWQC. There are no North Carolina or Federal ARARs for soil.

Maximum concentrations of compounds detected in the groundwater at Site 74 were compared with the NCWQS and the Federal MCLs. None of the compounds exceeded any state or Federal established criteria. No contaminants of concern, including pesticides, were detected in groundwater samples collected by Baker personnel during the pre-investigation sampling which was analyzed in accordance with CLP protocols, using USEPA Level IV data quality.

3.2.4.2 Location-Specific ARARs

Location-specific ARARs set restrictions on certain types of activities in wetlands, floodplains, and historical sites. On the basis of the available information, there do not appear to be any location-specific ARARs that apply to this site. The low lying area at the grease pit will be evaluated to determine whether it is a wetland.

3.2.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration. Action-specific ARARs for Site 74 will be identified when potential remedial action technologies have been selected.

3.2.5 Potential Remedial Technologies/Alternatives

The purpose of this section is to identify potential remedial technologies for each affected medium in order to identify what data may be necessary to evaluate technologies during the Feasibility Study.

3.2.5.1 Soil

Previous investigative studies have identified the presence of pesticide residuals in the surface soil. In addition, it has been reported that transformer oils containing PCBs may have been disposed in drums. Although the site requires further characterization, some remedial technologies have been identified for these areas based on the limited information. These technologies include thermal treatment (e.g., incineration), solidification/fixation, soil washing, and biodegradation. Each of these technologies will require specific data to evaluate them more thoroughly.

3.2.5.2 Sediment

There are no surface water bodies in the immediate vicinity of the site. Therefore, no remediation technologies are being considered for sediment at this time.

3.2.5.3 Groundwater

Early investigations at the site revealed the presence of low levels of pesticides in the groundwater. The quality of groundwater data from previous investigations is unknown. Groundwater samples were collected by Baker personnel during the pre-investigation sampling. These samples were analyzed for TCL organic and TAL inorganic parameters in accordance with CLP protocol using USEPA Level IV data quality. No contaminants of concern, including pesticides, were detected. These samples collected from monitoring wells 74GW1 and 74GW2. Neither of these wells is located in the immediate vicinity of the Grease Pit Disposal Area or the Former Pest Control Area. Groundwater samples collected from these monitoring wells may not be representative of groundwater quality conditions near the Grease Pit Disposal Area or the Former Pest Control Area. Therefore, additional analytical data is required in order to fully characterize groundwater quality and to assess human health and ecological risks, and evaluate remedial technologies should contamination be detected.

3.2.5.4 Surface Water

There is no surface water in the immediate vicinity of this site. Therefore, no remediation technologies are being considered for surface water at this time.

3.2.6 Data Limitations

The purpose of this section is to define data limitations with respect to either characterizing the site, assessing health and environmental risks, or evaluating potential feasible technologies. The analytical methods and the level of QA/QC used for the analyses of the data provided for review were not included in the background information received for this site, and, therefore, could not be reported in this Work Plan. Groundwater samples collected by Baker personnel at Site 74 during the pre-investigation sampling were analyzed for TCL organic and TAL inorganic parameters in accordance with CLP protocols, using USEPA Level IV data quality. These groundwater samples were collected from monitoring wells 74GW1 and 74GW2. These monitoring wells are not in the immediate vicinity of the Grease Pit Disposal Area or the Former Pest Control Area. Groundwater was the only media collected by Baker personnel during the pre-investigation sampling.

Consequently, the data provided are not suitable to fully characterize the site or to make an assessment of human health or ecological risks due to the contamination at Site 74. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Section 4.2 of this RI/FS Work Plan.

3.2.6.1 Waste and Debris

The types and estimated quantity of wastes disposed of at the site have been concluded through a review of available reports, a detailed analysis of historical aerial photographs, and a field investigation of geophysical indications. Samples of the wastes have not been collected to date.

3.2.6.2 Soil

Based on the area of Site 74 and the Grease Pit Disposal Area north of the dirt road (i.e., approximately 2 to 3 acres) and the limited amount of soil data at the Former Pest Control Area (e.g., six soil samples from two locations), the existing soil database appears inadequate to characterize the nature and extent of potential contamination within this area. In addition, more data is required to adequately assess human health and ecological risks presented by Site 74.

3.2.6.3 Groundwater

Pesticides were detected in groundwater samples collected during previous investigations at Site 74 (ESE, 1990). QA/QC protocol, data quality level, and overall quality of these samples is unknown. Groundwater samples collected by Baker personnel during the pre-investigation sampling (e.g., July 1992) were analyzed for TCL organic and TAL inorganic parameters in accordance with CLP protocol using USEPA Level IV data quality. No contaminants of concern, including pesticides, were detected.

These samples were collected from monitoring wells 74GW1 and 74GW2. Neither of these wells is located in the immediate vicinity of the Grease Pit Disposal Area or the Former Pest Control Area. The other site monitoring well 74GW3, which has not yet been located and is likely destroyed, is also not in the immediate vicinity of the Grease Pit Disposal Area or Former Pest Control Area. Groundwater samples collected from these monitoring wells may not be representative of groundwater quality conditions near the Grease Pit Disposal Area or the Former Pest Control Area. The existing groundwater monitoring network is inadequate for determining vertical or horizontal extent of contamination, or determining if an area of concern is acting as the source of groundwater contamination. In addition, more data is required to adequately assess human health and ecological risks, as well as remedial alternatives.

3.3 Site 41 - Camp Geiger Dump Near Former Trailer Park

3.3.1 Types and Volume of Wastes Present

Wastes including construction debris, industrial wastes which have not been defined, solvents, mirex, and ordnance were reportedly disposed of and possibly burned at the site. In addition, drums of unknown content were also reported to be buried at the site.

Information obtained from the IAS Report (Water & Air Research, 1983) indicated that between 10,000 to 15,000 gallons of solvents were disposed of at the site. Disposal methods (i.e., in drums or bulk disposal) and specific disposal locations are unknown. The IAS also reported that "tons" of mirex in bags were disposed of at the site. The area associated with the disposal of mirex is unknown.

Thousands of mortar shells, a box of grenades, and a 105mm Howitzer shell were also taken to the site and disposed of. It is unknown whether the mortar shells contain live munitions or just empty casings. The box of grenades and Howitzer shell are assumed to be unexploded and dangerous.

The area was used for disposal and burning during the period 1946 to 1970.

3.3.2 Potential Migration and Exposure Pathways

Based on the evaluation of existing conditions at Site 41, the following potential contaminant migration and exposure pathways have been identified:

Migration Pathways

- Overland surface runoff from the site to downslope areas and surface water bodies.
- Leaching of buried wastes to subsurface soils and groundwater.
- Groundwater discharge to surface water bodies or drainage areas.
- Contaminant infiltration from the shallow aquifer to the deeper aquifer.

Exposure Pathways

- Wildlife exposure due to dermal contact or incidental ingestion of soil, surface water, or sediment.

- Human exposure due to dermal contact or incidental soil ingestion which could occur during training/maneuvers, future construction, or future residence.

- Human exposure due to groundwater ingestion and dermal contact for a future residential scenario.

- Future potential human exposure due to ingestion of contaminated wildlife.

3.3.3 Preliminary Public Health and Environmental Impacts

The lack of surface or subsurface soil quality makes it difficult to assess potential impacts to military personnel who train in the area or who may use the area for hunting. In addition,

wildlife including deer, turkey, or bear could potentially be exposed to surficial or subsurface soil contamination. Based on the history of the site, there may be a potential risk of exposure to hazardous substances if these materials are present in surface soils (i.e., top three to six inches). Burrowing mammals or reptiles may be exposed to subsurface soil contamination.

Surface water and sediment data indicate that contaminants may have migrated from the site area to the unnamed tributary and Tank Creek. Wildlife inhabiting these surface water bodies may be exposed to site-related contaminants.

3.3.4 Preliminary Identification of ARARs

3.3.4.1 Chemical-Specific ARARs

Based on the analytical results from previous sampling activities, it appears that the contaminated media include groundwater, surface water, and sediment. Chemical-specific ARARs that may be applicable to groundwater or surface water include: the North Carolina Water Quality Standards for both groundwater and surface water; Federal MCLs established under the Safe Drinking Water Act; and AWQC. Chemical-specific ARARs to be considered for sediment include the USEPA Region IV sediment quality screening values.

Maximum concentrations of detected analytes in groundwater, surface water, and sediment were compared to the appropriate ARAR. As mentioned previously, groundwater data do not indicate a significant problem. However, the following contaminants in groundwater exceeded either State or Federal drinking water standards (see Table 2-8): dichlorodifluoromethane, vinyl chloride, cadmium, chromium, and lead.

Only one surface water contaminant exceeded AWQC. Aldrin was detected above the standard for protection of human health (i.e., ingestion of water and organisms). Sediment contaminants detected above the USEPA Region IV sediment screening values (e.g., ER-L value) include chromium and lead.

3.3.4.2 Location-Specific ARARs

Location-specific ARARs that may be applicable to remediation efforts include protection of wetlands that are present downslope of the former disposal area. If the wetland area required

remediation, this ARAR would be considered in the feasibility study. There are no other known location-specific ARARs.

3.3.4.3 Action-Specific ARARs

Action-specific ARARs are technology-based restrictions triggered by the type of action under consideration (e.g., discharge to navigable waters, offsite transport and disposal, etc.). Action-specific ARARs for Site 41 will be identified when potential remedial action technologies have been selected.

3.3.5 Potential Remedial Technologies/Alternatives

The purpose of this section is to identify potential remedial technologies for each medium that may require remediation. The technologies are identified at this stage in order to determine what data may be necessary to evaluate the technical aspects of implementation and effectiveness. The data required to assess the technologies will be collected during the RI.

3.3.5.1 Groundwater

Groundwater appears to be impacted with low levels of VOCs and possibly metals. The upgradient well location also detected elevated metals. Technologies applicable to these contaminants include: air stripping, carbon adsorption, UV/ozone oxidation, pumping, containment via extraction wells, and vapor extraction.

3.3.5.2 Soil

No soil data are available to assess the nature and extent of contamination. Based on the types of wastes taken to Site 41 (e.g., solvents, POL, ordnance, mirex, batteries), it appears that no one technology will be appropriate to remediate the problems. At this time, remediation technologies employing treatment cannot be assessed until additional information is gathered with respect to placement of the waste (i.e., are wastes segregated or combined), condition of wastes (i.e., are the wastes in drums), and characteristics of the wastes. Preliminary technologies that should be considered for Site 41 soils include: capping, offsite disposal, incineration, and solidification.

3.3.5.3 Sediment

Sediment data suggest that metals and explosive constituents may have migrated from the site to the downslope drainage areas. Only a limited amount of data are available to determine whether or not the sediments pose a risk to either human health or the environment. Remediation of sediments at this time does not appear to be justified. However, this will be evaluated during the RI and baseline human health and environmental risk assessments.

3.3.5.4 Surface Water

Surface water data suggest that pesticides may be present in water. The data, however, are not conclusive to determine whether direct or indirect remediation of surface water is necessary. Based on existing information, remediation of surface water is not believed to be feasible. This will be evaluated as part of the RI and human health and environmental risk assessments.

3.3.6 Data Limitations

The purpose of this section is to define the data limitations with respect to either characterizing the site, assessing human health and environmental risks/impacts, or evaluating potential remedial technologies or alternatives.

The existing data for Site 41 are limited in nature. The following subsections address the data limitations by media so that RI/FS objectives can be identified (Section 4.3) and appropriate field investigations can be defined to resolve the data deficiencies (Section 5.3.3).

3.3.6.1 Waste and Debris

The types and quantity of wastes taken to the site have been identified through existing information. However, the following data limitations have been identified.

- The actual locations within the 30-acre dump where wastes have been disposed is unknown.

- The mode of disposal (i.e., burning, drum disposal, bulk dumping, etc.) for these wastes is unknown.

- The placement of wastes with respect to whether the wastes are segregated or combined in one or more areas is unknown.

- The type or types of wastes contained in drums is unknown (refer to previous discussion of fire trucks being present during disposal).

3.3.6.2 Soil

No samples have been collected to assess surface or subsurface soil quality. Potential migration of soil contaminants to groundwater or downslope surface water/sediments cannot be assessed due to the lack of samples. There is no information to assess potential impacts to human health or the environment, or to characterize the waste for subsequent remediation, if required.

3.3.6.3 Groundwater

Groundwater data are limited with respect to evaluating shallow groundwater quality directly under the former dump. Also, the number of data points do not appear to be sufficient, due to the size of the study area, to assess potential offsite or vertical migration.

Parameters analyzed to date appear to be limited. No PCB or semivolatile analysis has been conducted during the two sampling rounds. Additionally, there is no information to assess the feasibility of remedial technologies. Hydrogeologic characteristics need to be estimated to evaluate potential migration pathways as well as remedial technologies such as pumping or containment of groundwater.

3.3.6.4 Surface Water/Sediment

The number of samples collected to date are not sufficient to fully characterize environmental impacts to the unnamed tributary or Tank Creek. Also, the parameters analyzed to date are limited to fully assess potential impacts to humans or wildlife.

4.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES

4.1 Site 69 - Rifle Range Chemical Dump

The field program for Site 69 has two stages: an initial evaluation of operational conditions and the RI. The initial evaluation will use limited time and personnel to prepare the site for the larger field investigation team accompanied by the heavy equipment subcontractors. The objective of the initial evaluation will be to reduce or eliminate delays in establishing data stations, minimizing the working time of the RI and optimizing the utilization of subcontracted services. The purposes of the initial evaluation will include:

1. Marking data stations for sampling.
2. Evaluating the array of data stations according to field conditions.
3. Providing access for equipment to the data stations.
4. Developing an initial assessment of groundwater conditions.

The initial evaluation will precede the RI by about two weeks and have a duration of only one or two days of field time. The field team will be limited to the Field Team Leader, a field geologist and the Site Manager; the field team for the initial evaluation may be accompanied by the ATEU, unexploded ordnance (UXO) Subcontractor, or Base personnel.

The RI objectives are to:

1. Identify the boundaries of the disposal areas.

2. Evaluate on-site and off-site groundwater quality (e.g., shallow and deep).

3. Determine the presence or absence of site-related contaminants in surface soil in order to conduct a human health risk assessment.

4. Evaluate surface water/sediment quality in site drainage areas.

5. Evaluate surface water/sediment quality of the watershed. This phase has already been conducted and the results are being evaluated.

Implementation of the field program accomplishing these objectives will include the following investigations:

1. Disposal Materials (e.g., Waste Characterization)
2. Soil Investigation
3. Groundwater Investigation
4. Surface Water and Sediment Investigation.

4.1.1 Waste Investigation Objectives

The objective of waste characterization has been assessed in respect to disposal practices and probable disposal materials. This characterization has been concluded through a review of available reports, a detailed analysis of historical aerial photographs and a field investigation of geophysical indications. As indicated on Figure 2-10, the probable areas of disposal form a crescent along the east and south sides of the site; this analysis is somewhat verified by the available aerial photography. No further intrusive investigation of wastes is proposed, since chemical agents are buried at this site. At the direction of the U.S. Army, investigation of chemical agents at this site is prohibited at this time.

4.1.2 Soil Investigation Objectives

Soils have been neglected in previous studies, primarily in reflection of the unacceptable hazard of exposure or disturbance of high-risk disposal materials. The objective of the RI investigation of soils is the characterization of contaminant releases to shallow soils throughout the disposal area, primarily by subsurface disposal and secondarily by direct, surficial disposal.

4.1.3 Groundwater Investigation Objectives

The groundwater investigation at Site 69 will involve characterizing the extent of off-site groundwater contamination in the shallow aquifer. In addition, potential contamination to the deep aquifer will be assessed. The subjects of the study of groundwater and springs include characterization of:

1. Groundwater flow and quality.

2. The transport of contaminants by the groundwater to subsurface and surface receptors.

Available descriptions of flow are qualitative, and are useful only in technically noncritical discussions. The probable pattern of flow at Site 69 would be complex and is likely very difficult to assess without extensive effort.

Current indications of groundwater quality are that no distribution of effluent has been found except to the south and southeast utilizing wells 69GW2 and 69GW3. A mapping of general trends of physical characteristics would be helpful in assessing flow directions. Physical parameters of groundwater quality, particularly temperature and specific conductance, are commonly affected by dissolution of inorganic and organic substances associated with contaminant distribution; the distribution of variation in these parameters and, subordinately, the absolute values of those parameters, indicates trends in contaminant distribution and transport. During the initial evaluation, the field parameters of temperature, pH, and specific conductance will be measured to map the distribution of those values. During the RI, comprehensive sequences will characterize the distribution of contaminants most probably associated with Site 69.

The objectives of the initial evaluation of groundwater flow are to:

1. Describe the probable directions and rates of flow using the available distribution of stations.

2. Review the station siting for augmentation of the monitoring system with minimal addition of wells (e.g., shallow and deep) in the water table.

The objectives of the RI are to:

1. Characterize the hydrologic parameters of the shallow groundwater related to the fate and transport of contaminants.

2. Evaluate the extent of off-site groundwater contamination and the probable trend of distribution within the surficial aquifer.

3. Provide reliable information to support the assessment of risks to human health presented by current patterns of exposure to the shallow groundwater.

4.1.4 Surface Water and Sediment Investigation Objectives

Surface water and sediment have been characterized at various locations around Site 69 by previous investigations and by an interim program conducted earlier in this project.

Surface water and sediment investigations will be conducted to identify the significance of the draws to the northeast and southeast of Site 69, and to assess human health and ecological impacts associated with these waters and sediment.

The objective of the initial evaluation of surface water and sediment is to identify the significance of the draws to the northeast and southeast of Site 69.

The objectives of the RI for surface water are to:

1. Assess effects of natural discharge from the shallow groundwater on local surface water.

2. Assess risks to human health and the environment associated with surface water use or exposure.

The objectives of the RI for sediment are to:

1. Assess the distribution of contaminant compounds to sediments of local streams and the New River from runoff and groundwater discharge.

2. Assess risks to human health and the environment associated with exposure to sediments in local streams.

3. Assess risks to human health and the environment associated with exposure to sediments in the New River.

4.2 Site 74 - Mess Hall Grease Pit Disposal Area

The field program for Site 74 has two stages: an initial evaluation of operational conditions and the RI.

The objective of the initial evaluation will be to reduce or eliminate delays in establishing data stations, minimizing the working time of the RI and optimizing the utilization of subcontracted services. The purposes of the initial evaluation will include:

1. Marking data stations for sampling.
2. Evaluating the array of data stations according to field conditions.
3. Providing access for equipment to the data stations.
4. Developing an initial assessment of groundwater conditions.

The initial evaluation will precede the RI by about two weeks and have a duration of only one or two days of field time. The field team will be limited to the Project Geologist/Field Team Leader, a field geologist and the Site Manager; the field team for the initial evaluation may be accompanied by the TEU or Base personnel, as desired by LANTDIV.

The RI objectives are to:

1. Identify the boundaries of the disposal areas and potential releases of contaminants to overlying soil cover.

2. Evaluate groundwater quality around the disposal areas.

3. Determine the presence or absence of contaminants in surface and subsurface soil to conduct a human health and ecological risk assessment.

Implementation of the field program accomplishing these objectives will include:

1. Disposal Materials (e.g., Waste Characterization)
2. Soil Investigation
3. Groundwater Investigation

4.2.1 Waste Characterization Objectives

Waste characterization has been assessed in respect to disposal practices and probable disposal materials. This characterization has been concluded through a review of available reports, a detailed analysis of historical aerial photographs and a field investigation of geophysical indications.

The indications from these approaches are that:

1. The rectangular area originally designated as the main disposal location (i.e., Mess Hall Grease Pit) has little indication of actual disposal of hazardous materials .

2. The elliptical area north of the eastern side of the Mess Hall Grease Pit has some indication of disposal of hazardous materials.

3. Trenches were excavated north of the grease pit, indicating that these areas may be associated with drum disposal.

4. The Former Pest Control Area shows little probable concern from a standpoint of buried materials.

Each of these areas will be addressed by the initial evaluation and by the RI of this project.

4.2.2 Soil Investigation Objectives

Minor amounts of pesticides have been detected in the surface soils of Site 74. However, only a limited sampling of soil has addressed part of the site; the remainder of the area has not been assessed.

The objectives of the RI of soil conditions are to:

1. Assess the vertical and horizontal extent of contaminant distribution at the former pest control area and grease pit area through sampling and chemical analysis.

2. Assess the effects on soils from past disposal practices.

3. Estimate the future effects of buried disposal materials on use of Site 74 for military operations.

4. Discuss the probable relation of groundwater quality of the water table, and the actual or potential occurrence of contaminants in soils.

4.2.3 Groundwater Investigation Objectives

Available descriptions of flow are qualitative, and are useful only in technically noncritical discussions. Present indications are that only two of the three on-site wells can be located. Well 74GW3 apparently is either lost in the overgrowth north of the expected disposal areas or has been destroyed; there is currently no precise survey that would facilitate discovery of this station.

A production well is located at Building 654. The operations cycle and pumpage of this well have not been documented. The effect of the quality of water in the shallow subsurface (i.e., water table) has not been assessed. The potential use of this well to indicate adverse effects on the groundwater regime has not been assessed.

There is no indication that springs or seeps from the water table should be present; therefore, the probability of a direct, local effect on the surface environment or surface receptors by groundwater quality is minimal.

Current indications of groundwater quality are that no distribution of effluent has been found. A mapping of general trends of physical characteristics would be helpful in assessing flow directions, although this will be restricted by the limited number and distribution of stations, expecting 74GW1, 74GW2 and Building 654 to be available.

The objectives of the initial evaluation of groundwater flow are to:

1. Describe the probable directions and rates of flow using the available distribution of found stations.

2. Review the options for augmentation of the monitoring system with minimal addition of wells (e.g., shallow and deep) in the water table.

The objectives of the RI of groundwater are to:

1. Characterize the hydrologic parameters of the shallow groundwater related to the fate and transport of contaminants.

2. Through additional groundwater monitoring points, evaluate the extent of off-site groundwater contamination and the probable trend of distribution from the shallow water table to the deeper layer supplying the well at Building 654.

3. Provide reliable information to support the assessment of risks to human health presented by current patterns of exposure to the shallow groundwater.

4.3 Site 41 - Camp Geiger Dump Near Former Trailer Park

The RI objectives for Site 41 include:

1. Assess the nature and extent of soil contamination at the former disposal area and downslope areas to assess human health and environmental risks.

2. Characterize groundwater quality throughout the former dump area to determine impacts from previous disposal operations.

3. Characterize the nature and extent of groundwater contamination in order to assess human health and environmental risks.

4. Characterize surface water and sediment quality in order to conduct a human health and ecological risk assessment.

5. Identify the contents of the former dump in order to select an appropriate remedial alternative, and to assess future potential impacts to the environment.

Implementation of the field program accomplishing these objectives will include:

1. Disposal Materials (e.g., waste characterization)
2. Soil investigation
3. Groundwater investigation

4. Surface water and sediment investigation

Specific RI/FS objectives for each media or area of concern is summarized in the following subsections.

4.3.1 Waste/Debris Investigation Objectives

The contents of the fill material as well as the characterization of surficial debris has not been defined. The following media-specific objectives have been identified.

1. Identify the boundary of the former disposal area and depth of fill material.

2. Determine areas within the 30-acre dump that may contain buried drums or metal debris (e.g., ordnance).

3. Identify surficial debris and determine whether the debris has impacted soil or groundwater quality.

The above three objectives will be met by performing the following investigations or studies.

- Conduct a geophysical investigation to locate subsurface anomalies that may be associated with buried drums or ordnance.

- Review historical photographs that may be available through the USEPA EPIC.

- Conduct an intensive site reconnaissance to identify all areas where surficial debris are located; the pre-scoping site visit was conducted in September 1993 when the ground surface was not discernible due to high and thick vegetative growth.

4.3.2 Soil Investigation Objectives

Soil data with respect to determining surface or subsurface impacts via previous disposal activities is required to perform the human health and ecological risk assessments, and to select an appropriate remedial alternative. The following objectives of the RI of soil conditions are to:

1. Characterize surface soil quality over areas of concern identified via the geophysical survey and/or site reconnaissance.

2. Characterize downslope surface soil quality to assess potential runoff of site-related contaminants.

3. Characterize soil quality at those locations where surficial debris is present.

4. Determine the nature and extent of soil contamination at areas of concern that may be associated with waste disposal; these areas will be identified via the geophysical investigation and/or review of EPIC historical photographs.

The above four objectives will be met by performing the following investigations or studies.

- Conduct a surface soil investigation focusing on downslope areas where contaminants may have migrated offsite via surface runoff.

- Conduct a soil investigation at those locations where surficial debris is encountered during the intensive site reconnaissance.

- Conduct a soil investigation following the geophysical investigation at those areas identified as potential waste disposal areas.

4.3.3 Groundwater Investigation Objectives

Limited groundwater data are available to assess shallow and deep groundwater quality or aquifer characteristics. The following objectives of the RI of groundwater conditions are to:

1. Characterize shallow and deep groundwater quality in the vicinity of the former disposal area.

2. Assess offsite groundwater quality to determine the horizontal extent of contamination.

3. Characterize deep groundwater quality downgradient of the former disposal area.

4. Characterize the geologic features of the site area

5. Characterize groundwater flow direction and aquifer characteristics to assess contaminant fate and transport as well as the evaluation of potential remediation technologies (e.g., groundwater extraction).

6. Evaluate impacts from nearby pumping wells with respect to flow direction and contaminant transport.

The above objectives will be met by conducting the following investigations and/or studies.

- Conduct a groundwater investigation to obtain shallow and possibly deep groundwater quality.

- Review and evaluate information obtained via aquifer testing at nearby sites to assess hydrogeologic characteristics.

- Obtain static water level measurements to better define groundwater flow direction.

- Locate nearby potable supply wells and assess potable water quality.

4.3.4 Surface Water/Sediment Investigation Objectives

Surface water and sediment data indicate that contaminants may have migrated from the former disposal area. However, the database is limited to only four sampling stations. The following objectives of the RI for surface water/sediment are to:

1. Assess upstream surface water/sediment quality to determine background characteristics.

2. Characterize surface and subsurface sediment quality in downslope surface water bodies (i.e., Tank Creek and the unnamed tributary) to determine whether former disposal practices have resulted in the contamination of these drainage areas.

3. Evaluate ecological risks/impacts based on newly-acquired surface water/sediment data.

4. Characterize surface water/sediment quality downstream of the study area.

The following investigations and/or studies will be conducted to meet the above four objectives.

- Conduct a surface water/sediment investigation of Tank Creek.
- Conduct a surface water/sediment investigation of the unnamed tributary to Southwest Creek.
- Compare surface water and sediment analytical data to relevant standards to assess potential impacts to aquatic life or stream habitat.
- Conduct toxicity tests to determine potential ecological impacts, if surface water/sediment results indicate the likelihood of adverse ecological impacts.

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

This section identifies the tasks and field investigation activities that will be needed to complete RI/FS activities at Sites 69, 74, and 41.

5.1 Task 1 - Project Management

Project Management activities involve such activities as daily technical support and guidance, budget and schedule review and tracking, preparation and review of invoices, manpower resources planning and allocation, and communication with LANTDIV and the Activity.

5.2 Task 2 - Subcontract Procurement

Task 2 involves the procurement of services such as drilling, ordnance clearance and monitoring, laboratory analysis, and data validation. Procurement of these services will be performed in accordance with the Comprehensive, Long-Term, Environmental Action Navy (CLEAN) Contract Procurement Manual. In the event that treatability studies are warranted, procurement of bench-scale or pilot-scale studies will be performed under this task.

5.3 Task 3 - Field Investigations

This section presents an overview of the field investigations to be conducted at Sites 69, 74, and 41. Specific details with respect to the investigative methods are provided in the Field Sampling and Analysis Plan (FSAP). The field investigations described in this section will provide data to meet the overall RI/FS objectives presented in Section 4.0 of this RI/FS Work Plan.

5.3.1 Site 69 - Rifle Range Chemical Dump

The following investigations and support activities will be conducted at Site 69:

- Initial Evaluation
- Surveying
- Soil Investigation
- Groundwater Investigation
- Surface Water/Sediment Investigation

These investigations are described below.

5.3.1.1 Initial Site Evaluation

A two to three day initial evaluation will be conducted at Site 69. The initial evaluation will involve the following activities:

- Visual inspection of surface soil to identify stained areas or seeps, or stressed vegetation for subsequent sampling which will be performed as part of the soil investigation.

- Define and mark the approximate boundary of the disposal area, based on existing geophysical transect identification stakes, and visual identification of former trenches.

- Identification of surface soil sampling locations at the former disposal area.

- Identification of background soil sampling locations.

- Collection of one round of water level measurements from all existing monitoring wells.

- Identification of hydropunch sampling locations along the northeast draw and southeast draw.

- Identification of proposed on site and off-site monitoring well locations.

- Clearance of any surficial obstacles (e.g., trees, vegetation) necessary to perform the off-site groundwater investigation.

- Identification of springs or seeps to be sampled as part of the surface water/sediment investigation.

- Surveying of sampling stations identified during this initial evaluation by a licensed surveyor.

5.3.1.2 Surveying

All existing wells have been surveyed under a separate contract task order. Newly installed monitoring wells, as well as soil sampling stations, will be surveyed by a qualified surveyor (i.e., registered to practice in the State of North Carolina). The top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. Latitude, longitude, elevation in feet of mean sea level, accuracy, and survey methods will be reported. The vertical accuracy will be 0.01 feet and the horizontal accuracy will be 0.1 foot. Soil sampling locations will be surveyed to an accuracy of 1 foot.

5.3.1.3 Soil Investigation

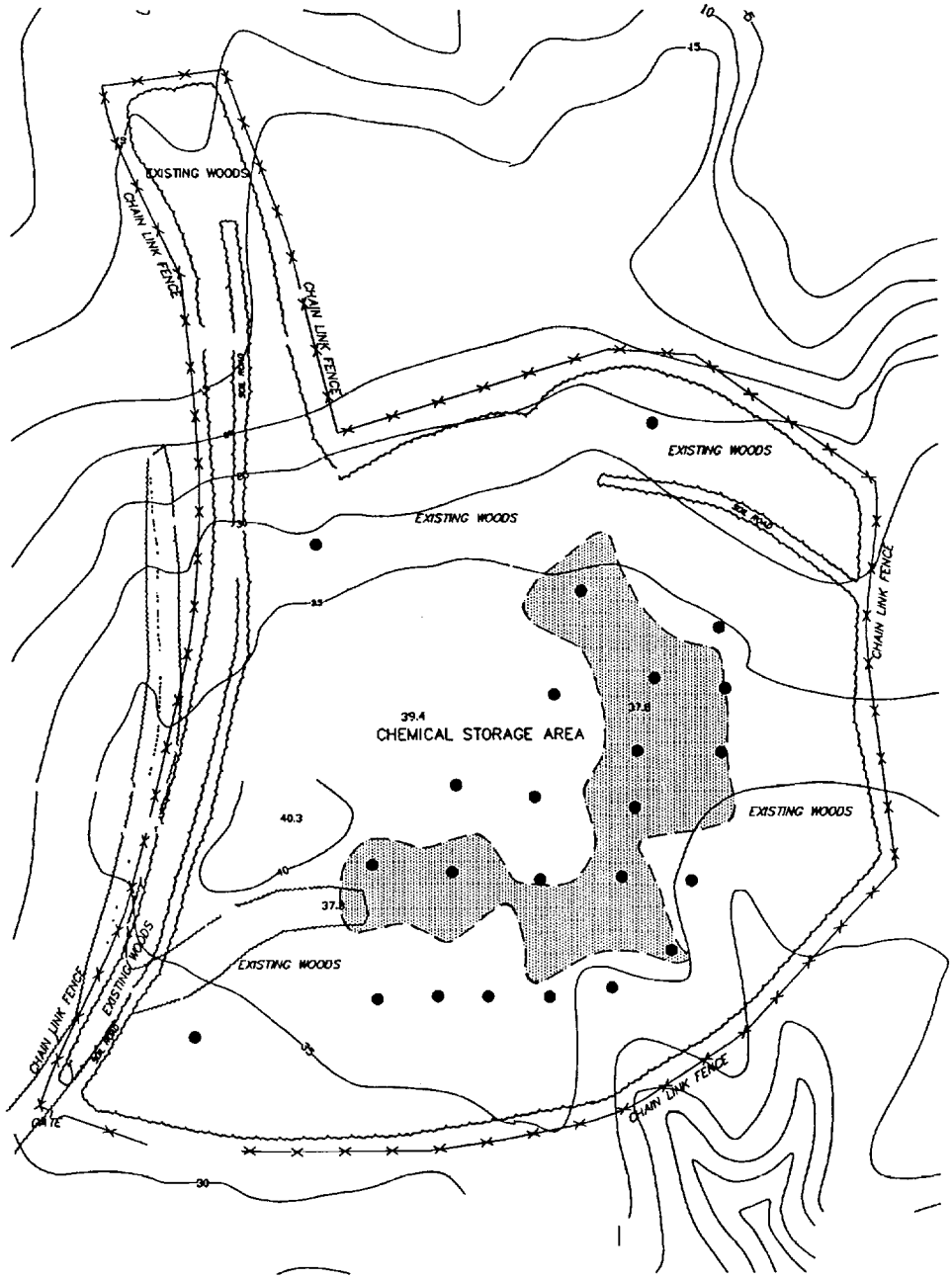
Soil characterization during the RI will comprise of sampling of soils to a depth not to exceed twelve inches. As discussed previously, subsurface soil samples will not be obtained due to the hazard of chemical agents buried at the site. As shown on Figure 5-1, approximately 21 surface samples will be obtained directly over or very near to the suspected disposal area. The actual sampling locations will be based on the initial evaluation of the site which is described in Section 5.3.1.1.

Three surface soil samples will be collected outside of the suspected disposal area, but within the fenceline. Four surface soil samples will be collected north and northwest of the site for background soil characteristics.

All samples will be collected using a decontaminated hand auger. The samples will be field screened by TEU for chemical agents. In the event that chemical agents are identified in the sample, the sample will be handled as a special waste (i.e., hazardous) and will not be analyzed. If no agents are identified, the sample will be handled as a routine environmental sample. Sample collection, handling, decontamination, and shipping requirements are provided in the FSAP in Sections 5.0 and 6.0.

All surface soil samples will be analyzed for full TCL organics and TAL inorganics in accordance with CLP protocols and Level IV data quality. In addition, the samples will be analyzed for chemical surety compounds (CSM) given on Table 5-1. The parameters listed on Table 5-1 are the expected parent degradation products that may be present in the environment. Table 5-2 summarizes the analytical program for the surface soil investigation.

106116WF



200 0 100 200 400

1 inch = 200 ft.

Baker

Baker Environmental, Inc.

LEGEND

- SAMPLING STATION FOR SURFICIAL SOIL
- DENOTES PROBABLE BURIED METAL
- FENCE
- VEGETATION
- TOPOGRAPHIC ELEVATION LINES

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 5-1
SITE 69
RIFLE RANGE CHEMICAL DUMP
PLANNED SOIL SAMPLING LOCATIONS

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

TABLE 5-1

TARGET CHEMICAL SURETY COMPOUND
DEGRADATION COMPOUNDS
MCB CAMP LEJEUNE, NORTH CAROLINA

Thiodigylcol
Hydroxyacetophenone
Acetophenone
Chloroacetophenone
bis(2-Chloroethyl)disulfide
bis(2-Chloroethyl)trisulfide
Hexachloroethane
Dithiane

Note: These compounds are suspected as a result of disposal at this site; these compounds are not routinely analyzed and require special analytical practices.

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 69	Soil - On site	24 surface soil	TCL Organics[2] TAL Inorganics[3] CSM[4]	IV IV IV	CLP/SOW[5] CLP/SOW Modified EPA 8270	Routine[6] Routine Routine
	Soil - Background	4 surface soils	TCL Organics TAL Inorganics CSM	IV IV IV	CLP/SOW CLP/SOW Modified EPA 8270	Routine Routine Routine
	Soil - Well Borings	5 borings/2 subsurface soil samples per boring	TCL Organics TAL Inorganics	IV IV	CLP/SOW CLP/SOW	Routine Routine
		1	Particle-Size Distribution	II	ASTM D422-63	Routine
		1	Atterburg Limits	II	ASTM D4943-89	Routine
	Groundwater - Hydropunch	14	TCL Volatile Organics	II	EPA 8240	24 hours
	Groundwater - Wells	14 (8 existing, 4 new shallow, 2 new deep wells)	TCL Organics TAL Inorganics CSM	IV IV IV	CLP/SOW CLP/SOW Modified EPA 8270	Routine Routine Routine
		2 (one shallow well and one deep well)	Microbial Count BOD_5 TOC COD Nitrogen (NH_4) Total Phosphorous Alkalinity	II II II II II II II	SM 907 SM 507, EPA 405.1 EPA 415.1 EPA 415.1, Hach EPA 350.3, 350.2 EPA 365.2 SM 403	Routine Routine Routine Routine Routine Routine Routine
	Surface Water-On Site	4 surface water (standing pools)	TCL Organics TAL Inorganics CSM	IV IV IV	CLP/SOW CLP/SOW Modified EPA 8270	Routine Routine Routine
		4 sediment	TCL Organics TAL Inorganics CSM	IV IV IV	CLP/SOW CLP/SOW Modified EPA 8270	Routine Routine Routine
	Surface Water-Drainage Areas	4 surface water	TCL Organics TAL Inorganics CSM	IV IV IV	CLP/SOW CLP/SOW Modified EPA 8270	Routine Routine Routine
		4 sediment	TCL Organics TAL Inorganics CSM	IV IV IV	CLP/SOW CLP/SOW Modified EPA 8270	Routine Routine Routine

TABLE 5-2 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 74	Soil - On Site	10 surface soil	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
	Soil - Well Borings	5 borings/2 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
		1	Particle-Size Distribution	II	ASTM D422-63	Routine
		1	Atterburg Limits	II	ASTM D4943-89	Routine
	Soil - Former Disposal Area	32 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
	Soil - Pest Control Area	19 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
	Groundwater	7 (2 existing, 5 new shallow)	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
		1	Microbial Count	II	SM 907	Routine
			BOD_5	II	SM 507, EPA 405.1	Routine
			TOC	II	EPA 415.1	Routine
			COD	II	EPA 415.1, Hach	Routine
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine
			Total Phosphorous	II	EPA 365.2	Routine
			Alkalinity	II	SM 403	Routine

TABLE 5-2 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 41	Soil - Downslope	12 surface soils	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance[7]	IV	EPA 8330	Routine
	Soil - Background	4 surface soils	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance[7]	IV	EPA 8330	Routine
	Soil - On-site Surficial Character-ization	25 borings/3 samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance[7]	IV	EPA 8330	Routine
	Soil - Well Borings	13 borings/3 subsurface soil samples per boring	TCL Organics	IV	CLP/SOW	Routine
			TAL Inroganics	IV	CLP/SOW	Routine
		2	Particle-Size Distribution	II	ASTM D422-63	Routine
		2	Atterburg Limits	II	ASTMD4943-89	Routine
	Groundwater - Wells	18 (5 existing, 7 new shallow, 6 intermediate wells)	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			CSM	IV	Modified EPA 8270	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance[7]	IV	EPA 8330	Routine
		2 (one shallow well and one intermediate well)	Microbial Count	II	SM 907	Routine
			BOD_5	II	SM 507, EPA 405.1	Routine
			TOC	II	EPA 415.1	Routine
			COD	II	EPA 415.1, Hach	Routine
			Nitrogen (NH_4)	II	EPA 350.3, 350.2	Routine
			Total Phosphorous	II	EPA 365.2	Routine
			Alkalinity	II	SM 403	Routine

TABLE 5-2 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITES 41, 69 AND 74
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time
Site 41 (cont.)	Surface Water-On Site	10 surface water	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance(7)	IV	EPA 8330	Routine
		20 sediment	TCL Organics	IV	CLP/SOW	Routine
			TAL Inorganics	IV	CLP/SOW	Routine
			Mirex	IV	EPA 8270A	Routine
			Ordnance(7)	IV	Ordnance	Routine
IDW	Soil Characterization	3 (one composite from each site roll-off box	TCL Organics	IV	CLP/SOW	14-day
			TAL Inorganics	IV	CLP/SOW	14-day
			Full TCLP	III	40 CFR 261	14-day
			Reactivity	III	40 CFR 261	14-day
			Corrosivity	III	40 CFR 261	14-day
			Ignitability	III	40 CFR 261	14-day
	Development/ Purge Water Characterization	3 (one sample from each tanker)	TCL Organics	IV	CLP/SOW	14-day
			TAL Inorganics	IV	CLP/SOW	14-day

(1) Baseline number of samples do not include field QA/QC samples.
(2) TCL Organics: Volatile Organics, Semivolatile Organics, Pesticides/PCBs
(3) TAL Inorganics:

Aluminum	EPA 3010/EPA 200.7	Cobalt	EPA 3010/EPA 200.7	Potassium	EPA 3010/EPA 200.7
Antimony	EPA 3010/EPA 200.7	Copper	EPA 3010/EPA 200.7	Selenium	EPA 3020/EPA 270.2
Arsenic	EPA 3020/EPA 206	Iron	EPA 3010/EPA 200.7	Silver	EPA 3010/EPA 200.7
Barium	EPA 3010/EPA 200.7	Lead	EPA 3020/EPA 239	Sodium	EPA 3010/EPA 200.7
Beryllium	EPA 3010/EPA 200.7	Magnesium	EPA 3010/EPA 200.7	Thallium	EPA 3020/EPA 279
Cadmium	EPA 3010/EPA 200.7	Manganese	EPA 3010/EPA 200.7	Vanadium	EPA 3010/EPA 200.7
Calcium	EPA 3010/EPA 200.7	Mercury	EPA 3010/EPA 245.1	Zinc	EPA 3010/EPA 200.7
Chromium	EPA 3010/EPA 200.7	Nickel	EPA 3010/EPA 200.7	Cyanide	EPA 3010/EPA 335.2

(4) CSM - Chemical Surety Materials
(5) CLP/SOW - Contract Laboratory Program/Statement of Work
(6) Routine analytical turnaround is 28 days following receipt of sample.
(7) Ordnance constituents include: HMX, ROX, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, tetryl, TNT, 1,3,5-trinitrobenzene, 2-amino-4,6-dinitrotoluene, 4 amino 2,6 dinitrotoleuen (EPA Method SW-846 8330).

Field duplicate samples will be collected on ten percent of the surface soil samples collected. Equipment rinsate blanks will be obtained on a daily basis (i.e., assume a three-day operation given that special precautionary measures will be employed). One field blank sample of the organic free, deionized rinse water will be collected. These samples will be analyzed for full TCL organics, TAL inorganics, and CSM degradation products. Trip blanks will accompany each cooler containing samples for volatile organic analysis (i.e., one trip blank sample will accompany each cooler containing samples for VOC analysis). Trip blank samples will only be analyzed for full TCL volatile organics.

5.3.1.4 Groundwater Investigation

In order to better characterize on site and off-site groundwater contamination, additional shallow and deep monitoring wells will be required. One on site shallow well is proposed northwest of the suspected disposal area. Since Site 69 is a topographically high area, and a groundwater divide is present at this site, the on site well will be located at the highest elevation within the area as shown on Figure 5-2. The area northwest of the disposal area is a topographic high area.

A second on site well will be paired with shallow well 69GW2, which historically exhibited the highest levels of VOCs. This well will monitor the deeper portion of the surficial aquifer in order to assess vertical contaminant migration. It is estimated that this well will be installed to a depth of approximately 45 to 50 feet below ground surface. The approximate elevation of the site with respect to the New River, which is located east of the site, is about 35 to 40 feet.

In order to assess the extent of off site groundwater contamination in the shallow aquifer, shallow monitoring wells will be installed downgradient from known areas of contamination. To help locate the extent of this contamination, shallow groundwater samples will be obtained from borings by "Hydropunching". Boreholes will be advanced at 50 foot spacings from the site beginning at the fence. This line of borings will advance from the northeast and southeast areas of the site where topographic drainage patterns are evident (see Figure 5-2). Initially, five to seven borings will be advanced and a sample of the groundwater collected.

The boreholes will be hydraulically pushed to the water table approximately 10 to 15 feet, and a sample of the groundwater will be obtained for field analysis of volatile organics using a field Gas Chromatograph PH (GC). The results will be available in 24 hours. If the outermost groundwater sample exhibits elevated levels of VOCs which are above standards, additional

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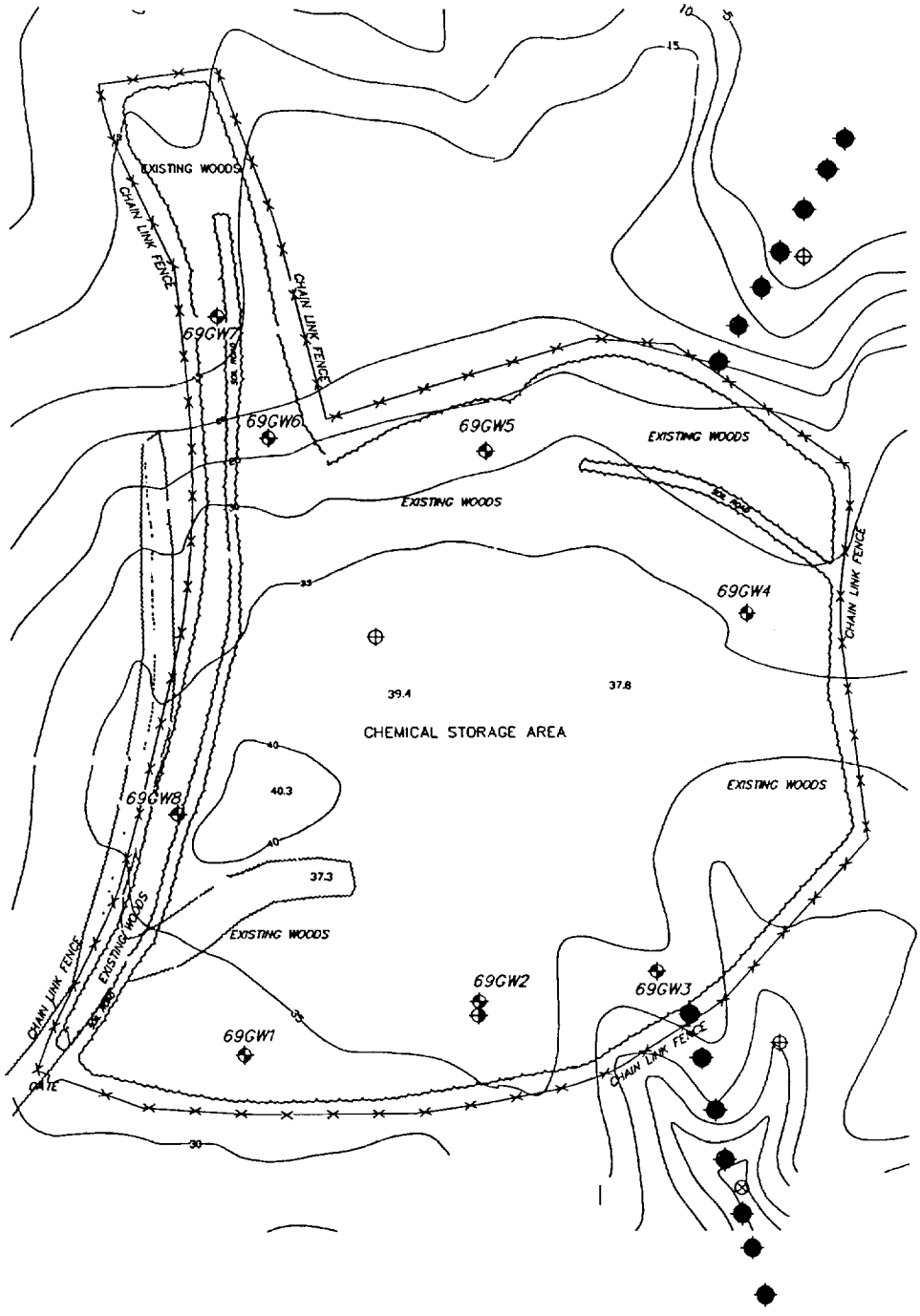

200 0 100 200 400

1 inch = 200 ft.

Baker

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LEGEND

- 69GW2 — EXISTING SHALLOW WELLS
- PLANNED DEEP WELL
- PLANNED SHALLOW WELL
- PLANNED PAIR OF SHALLOW AND DEEP WELLS
- PLANNED HYDROPUNCH LOCATION
- FENCE
- VEGETATION
- TOPOGRAPHIC ELEVATION LINES

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 5-2
SITE 69
RIFLE RANGE CHEMICAL DUMP
PROPOSED SHALLOW AND DEEP WELL LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

borings will be required. This will continue until the extent of contamination in the shallow aquifer can be defined. The extent will be defined when two consecutive hydropunch samples do not exhibit VOC contamination.

At a minimum, one shallow monitoring well will be constructed northeast and southeast of the site, based on the results of the hydropunch investigation. The wells will be located off site in an area believed to be "clean". One shallow well will be installed southeast of the site, approximately 175 feet southeast of well 69GW3, where contamination is likely, based on existing groundwater information. In addition, a second deep monitoring well will be constructed southeast of the site. This well will be paired with the shallow monitoring well to be located in what should be an uncontaminated zone, based on the hydropunch data.

The proposed hydropunch survey lines of investigation as well as the proposed shallow and deep monitoring wells are illustrated on Figure 5-2.

Monitoring well test borings will be augered and soil samples collected using American Society for Testing and Materials (ASTM) Method D1586-84. Soil samples will be collected with a split spoon for 2-foot intervals along 2-foot centers until the first 2-foot interval below the water table. The surface soil (i.e., top twelve inches) and two subsurface soil samples (i.e., mid-depth and just above the water table) will be submitted for chemical analysis which consists of full TCL organics and TAL inorganics as shown on Table 5-2. In addition, one subsurface soil sample collected at one of the stations will be submitted for engineering parameters including particle size distribution and Atterburg limits.

All monitoring wells will be constructed of 2-inch polyvinylchloride (PVC) casing and screen. The screen will be schedule 40 and ten feet in length. The shallow wells will be constructed to a depth of approximately 20 to 25 feet so that the screen is set at least 10 feet below the top of the water table. The deeper well will be constructed the same as the shallow well except that it will be set at a depth of approximately 45 to 50 feet bgs. Monitoring well construction details and drilling procedures are provided in the FSAP Sections 5.0 and 6.0. The hydropunch technique is also described in the FSAP.

One round of groundwater samples will be collected from the eight existing monitoring wells, four proposed shallow monitoring wells, and two proposed deep wells. All groundwater samples will be analyzed for full TCL organics, TAL inorganics (i.e., total and dissolved metals) in accordance with CLP protocols and Level IV data quality. Chemical surety

degradation products will also be analyzed through a certified surety laboratory. One shallow and one deep groundwater sample will be collected from well 69GW2 for analysis of engineering parameters including: microbial count, biological oxygen demand (BOD), total organic carbon (TOC), chemical oxygen demand (COD), ammonia nitrogen (NH_4), total phosphorous, and alkalinity. Specific conductance, temperature, and pH will be measured in the field.

QA/QC samples will include duplicate samples, equipment rinsate blanks, field blanks, and trip blanks. Two duplicate samples will be collected: one from well 69GW2 and one from the newly installed on site deep monitoring well. Equipment rinsate blanks will be obtained each day. It is anticipated that the wells will take one to two days to sample. Trip blanks will be included with coolers containing samples for volatile organic analysis. A field blank will be collected as part of the soil investigation and therefore, another field blank will not be necessary under this investigation.

The sampling and analytical program is summarized on Table 5-2.

5.3.1.5 Surface Water/Sediment Investigation

Surface water/sediment samples will be collected from standing pools of water at Site 69, and from springs/drainage areas northeast and southeast of the site as shown on Figure 5-3. Previous site reconnaissances have noted standing water in various locations of Site 69, particularly near the southern portion of the site near the fence. Three to four pools of standing water, if present during the time of sampling, will be sampled. One surface water and sediment sample in which the sediment is actually a saturated soil sample, will be collected from each pool of standing water.

During the initial evaluation (described under Section 5.3.1.1), springs or drainage seeps will be identified in the drainage areas northeast and southeast of the site. At least two samples of the surface water/sediment in these drainage areas will be collected. The first sample will be collected at the location where water is first encountered walking from the site. The second sampling station shall be identified several hundred feet downstream.

Surface water samples will be collected by dipping the sample bottles directly into the water or by using a clean glass container to obtain the sample, and pouring the sample directly into the appropriate sample bottles. Sediment samples will be collected using a hand coring device.

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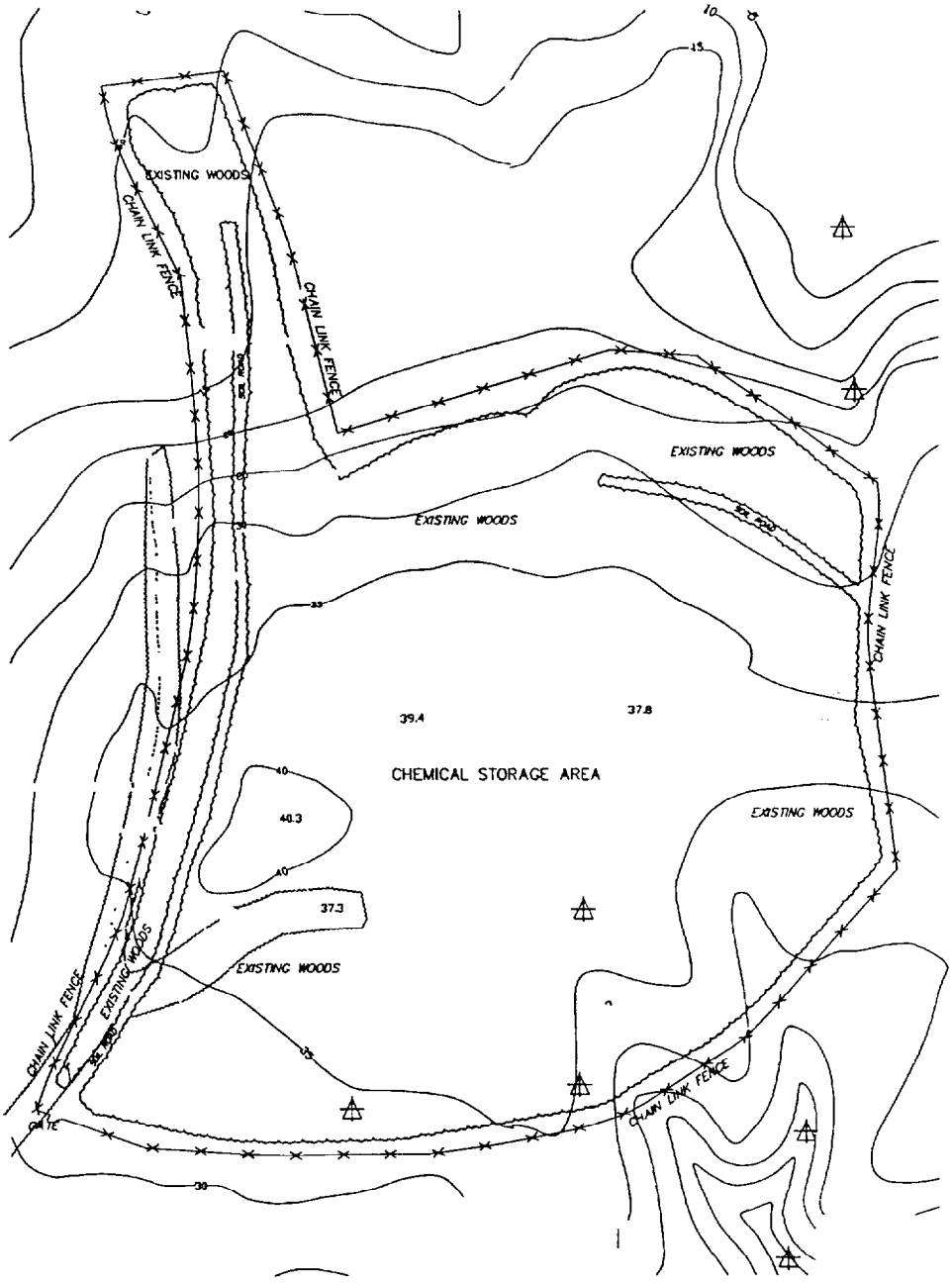

200 0 100 200 400

1 inch = 200 ft.

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LEGEND

- PLANNED SURFACE WATER/SEDIMENT STATION
- FENCE
- VEGETATION
- TOPOGRAPHIC ELEVATION LINES

SOURCE: REVISED FROM LANTDIV, OCT. 1991

FIGURE 5-3
SITE 69
RIFLE RANGE CHEMICAL DUMP
PROPOSED SURFACE WATER/
SEDIMENT SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Sampling procedures, preservation requirements, decontamination, and shipping requirements are described in the FSAP in Sections 5.0 and 6.0.

All surface water and sediment samples will be analyzed for full TCL organics, TAL inorganics, and CSM. A summary of the proposed sampling and analytical program is given in Table 5-2.

One field duplicate sample of surface water and sediment will be collected. This sample will be analyzed for the same parameters as the "primary" sample. Trip blanks will be prepared using organic free, deionized water and submitted with the coolers containing samples for volatile organic analysis. Trip blanks will only be analyzed for TCL volatile organics. Equipment rinsate blanks (i.e., final rinse of the sediment coring device) will be submitted on a daily basis. This activity is planned for a one day event.

5.3.2 Site 74 - Mess Hall Grease Pit Disposal Area

The following investigations and support activities will be conducted at Site 74:

- Initial Evaluation
- Surveying
- Soil Investigation
- Groundwater Investigation

These investigations are described below.

5.3.2.1 Initial Evaluation

The initial evaluation will include a visual inspection of the surface of each area of concern at Site 74 for appearances of soil staining or stressed vegetation. Areas so noted will be considered to reflect subsurface releases of artificially introduced substances representing potentially hazardous materials. One hundred-foot traverses across each area will be walked by two members of the field team.

The initial evaluation will also include the following:

- Identification of at least four background soil sampling locations.
- Surveying of existing monitoring wells.
- Collection of one round of water level measurements from existing wells.
- Calculation of groundwater elevations and representation of groundwater flow, considering the influence of the supply well (well No. 654) located near the former grease disposal area.
- Visual inspection of the area for springs or seeps that may not have been apparent during earlier site reconnaissances.
- Identification and marking of on-site sampling grids (see Soil Investigation).
- Identification and marking of proposed monitoring well locations.
- Clearance of any surficial obstacles (i.e., trees, vegetation) necessary to perform the groundwater investigation or test boring operations.

5.3.2.2 Surveying

Monitoring wells, surface soil sampling stations, and test borings will be surveyed by a qualified surveyor (i.e., registered to practice in the State of North Carolina). For the monitoring wells, the top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. Latitude, longitude, elevation in feet of mean sea level, accuracy, and survey methods will be reported. The vertical accuracy will be 0.01 foot and the horizontal accuracy will be 0.1 foot. Soil sampling stations will be surveyed to an accuracy of 1 foot.

5.3.2.3 Soil Investigation

The soil investigation will include the following sampling programs:

- Collection of surficial soil samples (0 to 12 inches).
- Collection of surface and subsurface soil samples from the former pest control area and former disposal areas.
- Collection of subsurface soil samples from monitoring well boreholes.

Surficial Soil Sampling

Surface soil samples will be collected at areas exhibiting stressed vegetation or staining, as noted during the initial evaluation of the site (see Section 5.3.2.1). If no such areas are identified, five random surface soil samples will be collected near the former disposal area and five random surface soil samples will be collected near the former pest control area. Although the exact number of surface soil samples is unknown and will be determined in the field, ten locations will be assumed for cost estimating purposes only. Four background soil samples will also be collected. The locations will be located upgradient of the site.

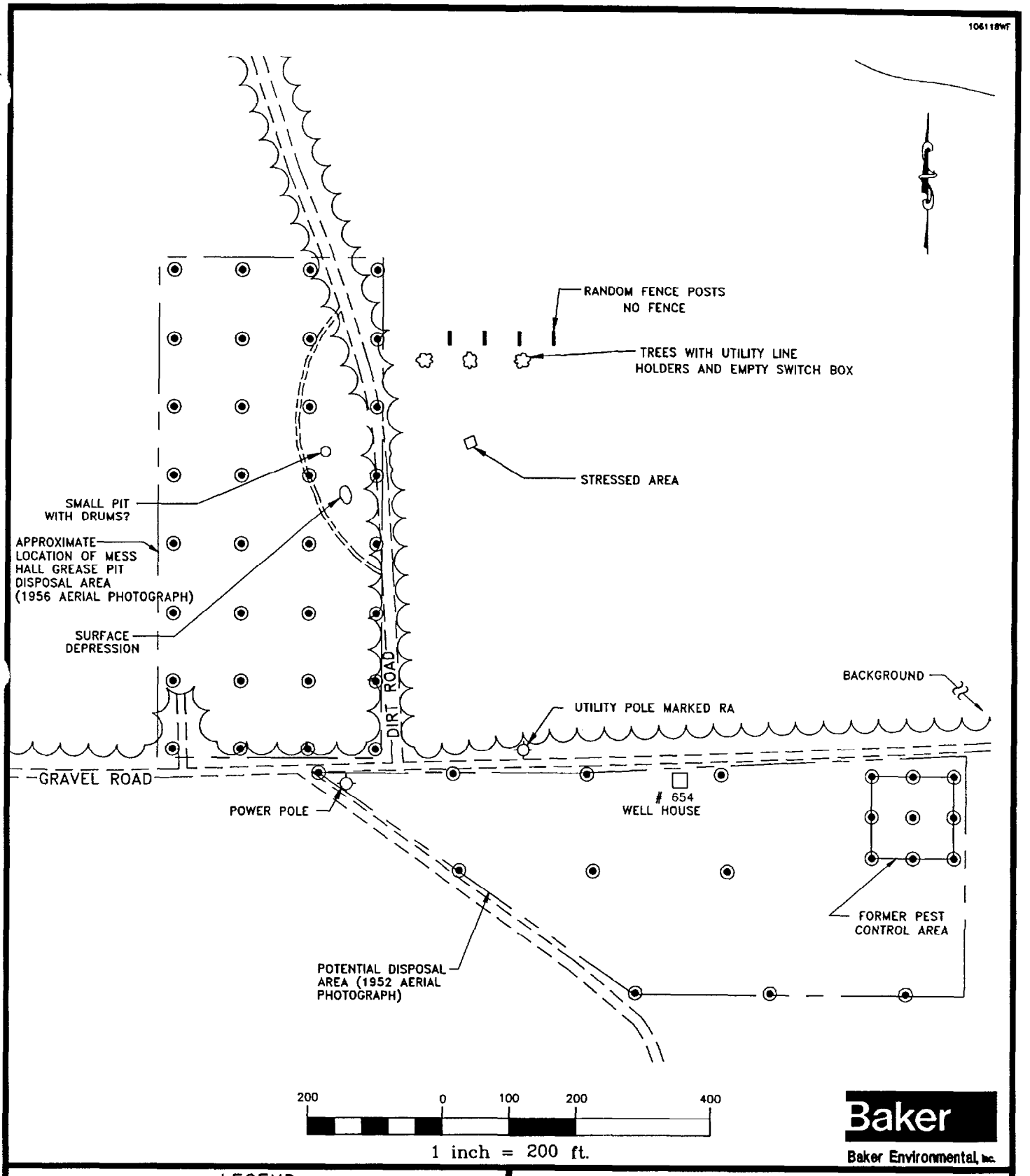
All surface soil samples will be collected using a decontaminated hand trial. Sampling procedures, decontamination procedures, and sample handling and shipping requirements are described in the FSAP in Sections 5.0 and 6.0.

Surface soil samples will be analyzed for full TCL organics and TAL inorganics. Surface soil samples collected near the former disposal area also will be analyzed for CSM degradation products.

Soil Investigation

A soil investigation will be conducted at the former pest control area, the potential disposal area which surrounds the pest control area, and the former disposal area north of the access road as shown on Figure 5-4. Sampling grids will be established to cover all three areas.

A 50 by 50-foot sampling grid will be established at the former pest control area (a total of nine grid points). A 200 by 200-foot sampling grid (a total of eight grid points) will be established outside of the pest control area to evaluate potential disposal operations which



LEGEND

- SOIL BORING SAMPLING LOCATIONS
- ROAD (UNIMPROVED)

SOURCE: REVISED FROM LANTDIV. OCT. 1991

FIGURE 5-4
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA
SOIL INVESTIGATION SAMPLING LOCATIONS

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

were noted on historical photographs. The area north of the access road (gravel road) will be investigated by establishing a 100 by 100-foot sampling grid (a total of 32 grid points) in the area where trenches were identified in historical aerial photographs.

Test borings will be augered at each grid point in accordance with ASTM Method D1586-84. Soil samples will be collected with a split spoon at 2-foot centers until the first 2-foot interval below the water table. A maximum of three soil samples from each test boring will be submitted for chemical analysis. These samples shall include a surficial soil sample (top 12 inches), a sample from mid-depth between the ground surface and the water table, and a sample from just above the water table. If high water table conditions are encountered (e.g., less than 6 feet bgs), three samples from each borehole will not be attainable.

Surface soil samples collected near the former disposal area (i.e., the area north of the main road) will be analyzed for TCL organics, TAL inorganics, and CSM with Level IV data quality. Surface soil samples collected near the former pest control area will be analyzed for full TCL organics and TAL inorganics with Level IV data quality.

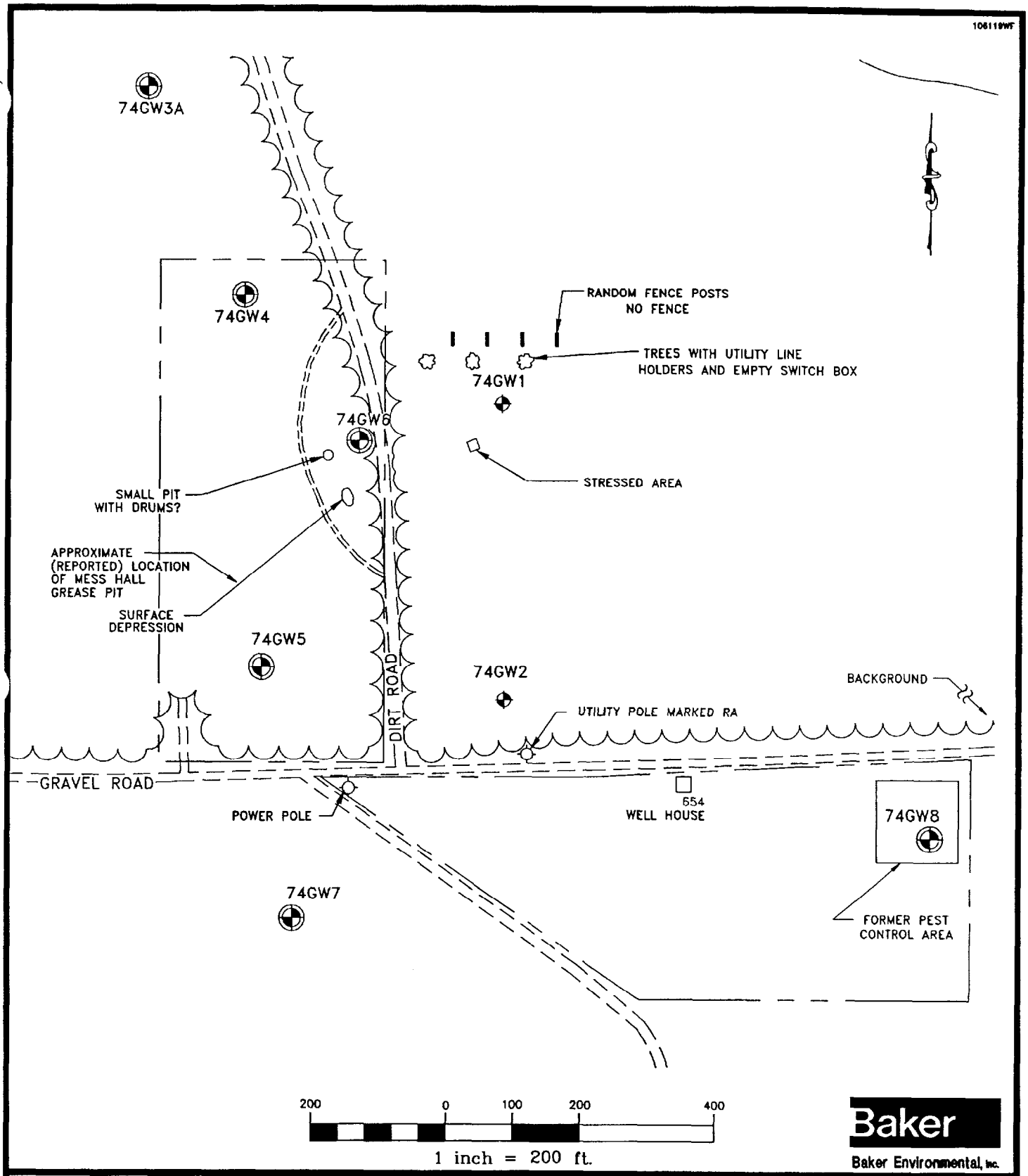
Monitoring well test borings will be augered and soil samples collected using ASTM Method D1586-84. Soil samples will be collected with a split spoon for 2-foot intervals along 2-foot centers until the first 2-foot interval below the water table. The subsurface soil samples will be submitted for chemical analysis including full TCL organics and TAL inorganics as shown on Table 5-2. In addition, one subsurface soil sample collected at one of the stations will be submitted for engineering parameters (i.e., particle size distribution, Atterburg limits).

Field duplicate samples will be collected at a rate of one sample per ten surface soil samples collected. Equipment rinsate blanks (e.g., final rinse water of the split spoon or trial) will be submitted daily. Trip blanks will be submitted with each cooler containing samples for volatile organic analysis. One field blank and will be submitted for the entire investigation at Site 74.

5.3.2.4 Groundwater Investigation

The groundwater investigation will involve the following activities:

- Installation of a minimum of five monitoring wells at locations selected during the initial evaluation. Approximate locations are shown on Figure 5-5.



LEGEND

74GW1 – EXISTING SHALLOW WELL

74GW4 – PLANNED SHALLOW MONITORING WELL

SOURCE: REVISED FROM LANTDIV. OCT. 1991

FIGURE 5-5
SITE 74
MESS HALL GREASE PIT DISPOSAL AREA
GROUNDWATER INVESTIGATION
SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

- Collection of static water levels and performance of slug tests on all newly installed monitoring wells.

- Collection of one round of samples from all monitoring wells for full TCL organics and TAL inorganics (total and dissolved). CSM will also be analyzed for in all wells except well 74GW8. In addition, one groundwater sample will be analyzed for engineering parameters (see Table 5-2).

The principal interest of the investigation will be the shallow water table. Subsidiary indications of the potential distribution of contaminants from the shallow water table to the Castle Hayne aquifer supplying potable water via Supply Well 654 will be addressed by analysis of flow vectors and head relationships. Supply Well 654 is sampled periodically for full organic and inorganic analysis. No contamination has been detected to date.

Field duplicate samples will be collected at a rate of one sample per ten surface soil samples collected. Equipment rinsate blanks (e.g., final rinse water of the split spoon or trial) will be submitted daily. Trip blanks will be included with coolers containing samples for volatile organic analysis. One field blank will be submitted for the entire investigation at Site 74. A summary of the sampling and analytical program is given on Table 5-2.

5.3.3 Site 41 - Camp Geiger Dump Near Former Trailer Park

The following investigations and support activities will be conducted at Site 41:

- Initial Evaluation
- Surveying
- Site Reconnaissance
- Geophysical Survey
- Soil Investigation
- Groundwater Investigation
- Surface Water/Sediment Investigation

These investigations are described below.

5.3.3.1 Initial Evaluation

The initial site evaluation will be conducted to address and resolve potential problems that may be encountered during the various site investigations. The initial evaluation will be conducted approximately one to two weeks prior to the mobilization of the field team and subcontractors. The initial evaluation will include the following activities:

- Identification of background and downslope soil sampling areas.
- Identification of appropriate surface water/sediment sampling stations.
- Identification of drainage areas between the former disposal area and the unnamed tributary and Tank Creek (i.e., along the hillsides surrounding the site).
- Identification of proposed monitoring well locations.
- Clearance of any surficial obstacles necessary to perform the geophysical survey, or to gain access to monitoring well locations.

5.3.3.2 Surveying

All existing and newly-installed monitoring wells will be surveyed by a qualified surveyor (i.e., registered to practice in the State of North Carolina). The top of the protective casing, the top of the well casing, and the elevation of the ground surface will be surveyed. Latitude, longitude, elevation in feet of msl, accuracy, and survey methods will be reported. The vertical accuracy will be 0.01 foot and the horizontal accuracy will be 0.1 foot.

All surface soil locations and test borings will be surveyed to an accuracy of 1 foot. Traverses spaced at 50 feet across the site will also be established by the surveyor and depicted on the base map. The traverses will be used to perform the site reconnaissance and geophysical survey.

Aerial topographic mapping, by photogrammetic methods, will be produced of a 70-acre area encompassing the former dump and surrounding area. Vertical control shall conform to MSL 1929 datum. Horizontal control shall be based on the MCB Camp Lejeune surveyed coordinate

system. A survey baseline will be established at the site to be used as a reference for field location work.

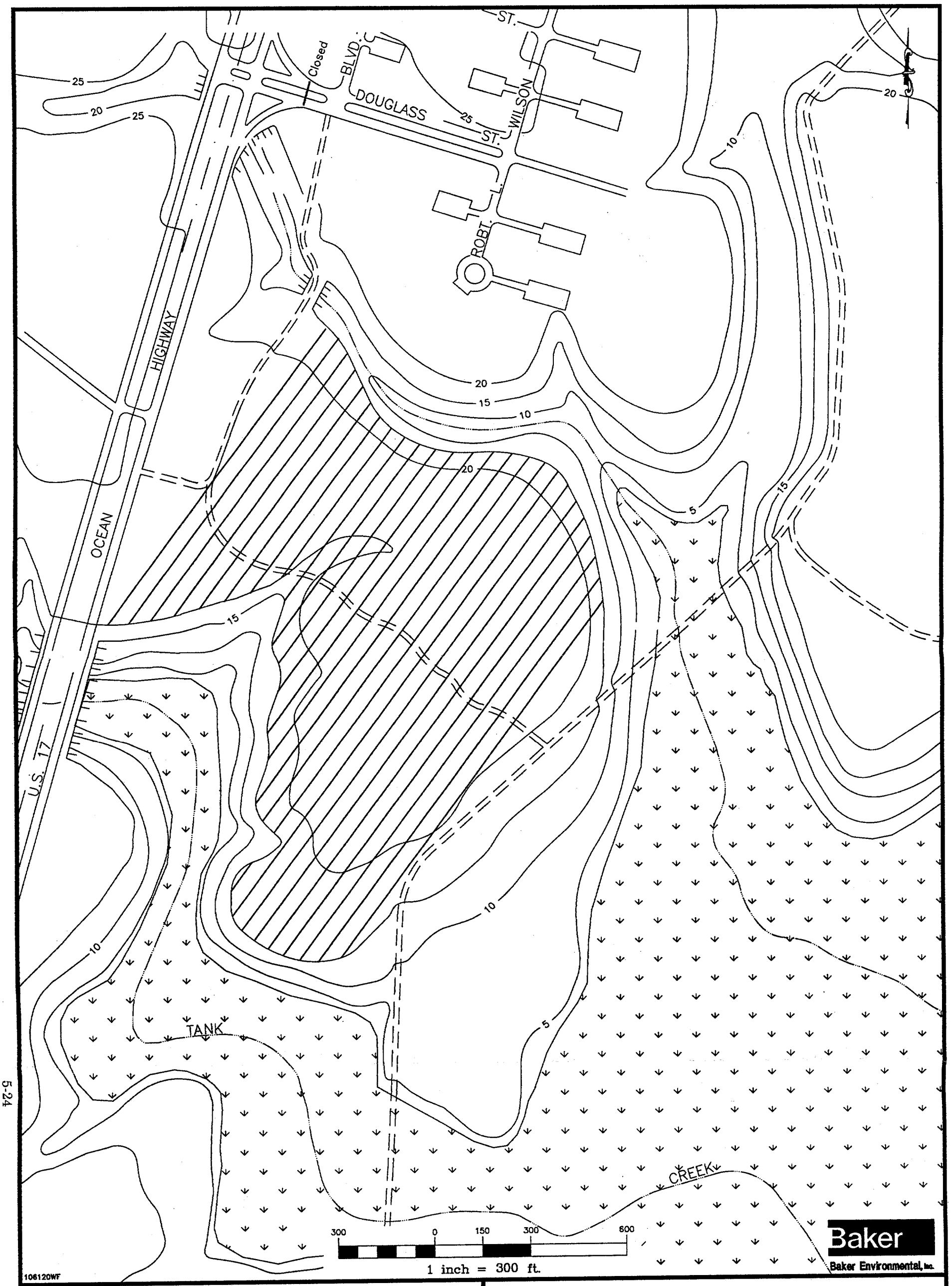
The topographic mapping will be produced at a scale of 1" = 100' with a contour interval of one foot. Additional surveyed locations and elevations will be obtained for detail. The finished products will consist of the following:

- A reproducible mylar drawing of existing conditions.
- One drawing bearing the seal of a certified land surveyor registered to practice in North Carolina.
- A 3-1/2" high density diskette containing the three dimensional file in an AutoCADD, version 12, recognized *.DWG or *.DFX conversion file format.

5.3.3.3 Site Reconnaissance

A site reconnaissance will be conducted along 50-foot traverses over the former disposal area (see Figure 5-6). The purpose of the site reconnaissance is to identify surficial disposal areas that may have resulted in soil or groundwater contamination. A pre-scoping site visit was conducted in September 1993 by the project team to examine the physical layout of the study area. During the site visit, numerous piles of debris and scattered drums were identified at various locations. However, due to the thick vegetative cover, it was difficult to identify all objects (e.g., drums, canisters, debris) along the ground surface. Based on the initial pre-scoping site visit, piles of debris including a few drums and canisters were observed throughout the site. Further investigation of these areas are warranted.

The reconnaissance will first involve the establishment of 50-foot traverses across the study area. The traverses will also be utilized as part of the geophysical investigation described in Section 5.3.3.4. Project team members will walk along the traverses and identify all surficial anomalies for subsequent mapping. Those anomalies that may be associated with waste disposal (e.g., canisters or drums, or stressed vegetation) will be marked in the field and investigated as part of the soil investigation. Construction debris areas will not be subject to subsequent sampling. Based on the project schedule, the field investigation at Site 41 will be conducted in January. Therefore, the vegetative cover should be at a minimum.



LEGEND

- ——— – DENOTES GEOPHYSICAL INVESTIGATION TRAVERSE LINE AT 50–FOOT SPACINGS
- ↓ ↓ – MARSH
- —5— – TOPOGRAPHIC ELEVATION LINES
- ═══ – ROAD (IMPROVED)
- = = = – ROAD (UNIMPROVED)
- ~~~~ – INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 5–6
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
GEOPHYSICAL COVERAGE
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02317S05Z

5.3.3.4 Geophysical Investigations

Existing information indicates that wastes including POL, solvents, batteries, ordnance, mirex in bags, and drums were disposed of during the period 1946 to 1970. Currently, there is no information regarding placement of these wastes. Based on discussions with base personnel and experience at other base disposal areas, the wastes are likely buried in shallow trenches. Some of wastes were probably ignited prior to backfilling, based on previous reports (Water & Air Research, 1983). Due to the relatively high water table, the trenches are probably 3 to 10 feet in depth and several feet in width (e.g., 3 to 5 feet).

Geophysical investigations will be conducted at Site 41 to locate former disposal areas, possible buried drums, and ordnance. The results of the geophysical investigations will be used in the soil and groundwater investigations in order to assess the nature and extent of soil and groundwater contamination.

Geophysical techniques will include electromagnetic (EM) terrain conductivity and a newly-developed technique known as Surface Towed Ordnance Locator System (STOLS).

EM is a geophysical technique for delineation of buried, non-metallic wastes abandoned trenches, or anomalies associated with lenses or pockets of different materials. EM surveying also is particularly effective for detection of buried metal objects such as pipelines, drums, tanks, and metal debris. EM data will be acquired by traversing predetermined survey lines spaced 50-feet apart throughout the former disposal area. Where anomalies are detected, "tighter" traversing will be performed to better delineate the areas of concern. Data will be recorded digitally and transferred to a portable computer which will be used to generate conductivity contour maps and/or profiles.

STOL is a second generation system based on a demonstration prototype STOLS developed by the Navy and GEO-CENTERS, INC. under NRL Contract N00014-86-C-2266. STOLS will be employed to locate buried ordnance for which it was developed and drums.

The STOLs is an array of commercial total field magnetometers which is towed by an off-road vehicle. Data are acquired using a computer driven data acquisition search system. Field data are transferred to a field deployed command center computer for off-line analysis, processing and magnetic anomaly map generation.

The mission objectives of the systems are to:

- Detect and locate buried ordnance with an accuracy of ±1 meter and depth to 5 meters.
- Carry out analysis of daily survey data, on site and overnight.
- Generate hard copy site reports and target maps.

STOLS offers rapid and accurate survey capability with archival records. It has been demonstrated that large tracts can be swept with quantitative accuracy to yield maps of target locations and covered areas.

The STOLS tow vehicle is a six-wheel off-road platform custom modified prime movers. Its computerized control unit can acquire and store 4.5 hours of continuous data. This would be comparable to approximately half of one day's survey. An on-board microwave system updates the tow vehicle location each second to ± 1 meter accuracy.

The STOLS tow platform is a stable four wheel trailer employing nonmagnetic materials for a low magnetic self-signature. Magnetic field sensors are spaced 0.5 meters apart on a folding boom with an effective sweep width of 3 meters (10 feet). The sensors are cesium vapor magnetometers which measure total magnetic field. Custom built interface electronics acquire 20 readings per second from each sensor with 1 gamma resolution.

Because natural fluctuations in the earth's magnetic field can affect survey precision, STOLS incorporates a reference magnetometer base station. Data from a tripod mounted cesium vapor sensor are recorded simultaneously with the magnetometry survey and are stored on a removable data cartridge for post-processing to remove any drift.

Four portable, stand-alone remote microwave navigation stations, deployed on a perimeter of the survey area, relay range locations data to the master navigation system on the tow vehicle.

Field data are transferred by an umbilical cable and/or a personal computer (PC) based storage media from the tow vehicle to the command center for immediate processing. The data are decompressed and contemporaneous reference data are subtracted from the field data to

yield residual or anomalous, magnetic field readings. From the Navigation and magnetometer, data are sorted and gridded into a two dimensional array. An image file is constructed from the data array and are displayed as quarter-acre quadrants in either gray scale or pseudocolor on a high resolution color monitor.

The target analysis algorithm is used to estimate initial target location. The initial estimate is used as the seed for a recursive model-matching algorithm which performs a least-square fit of a dipole magnetic model to the field survey data. The derived dipole coordinates are reported as target location and depth, while the dipole moment is used to classify the target as small, medium or large.

STOLS command center software is a menu-driven package written in the C programming language which is widely used in scientific applications and imaging systems. The software allows the user to set up a survey, load data from the tow vehicle or archive tapes, process the data, analyze the data for target estimates and produce maps and reports of field activities.

5.3.3.5 Soil Investigation

The investigation of soil conditions at Site 41 will involve three separate investigations, each with a specific objective. These investigations will focus on the following:

- Assessment of surface quality downslope of the former disposal area
- Assessment of background soil quality
- Characterization of surface and subsurface soil quality at suspected disposal areas identified during the site reconnaissance
- Characterization of soil from monitoring well boreholes for correlation to groundwater analyses
- Characterization of soil for engineering parameters

The various components of the soil investigation are described below.

Assessment of Downslope and Background Soil Quality

Because the former disposal area is situated at a topographic high area, downslope soils may be contaminated via surface runoff. In order to assess this, 12 surface soil samples (i.e., top twelve inches) will be collected along the hillside surrounding the former disposal area (see Figure 5-7).

Four soil samples will be collected northeast of the site in a wooded area not believed to be associated with previous disposal activities for purposes of evaluating background soil characteristics.

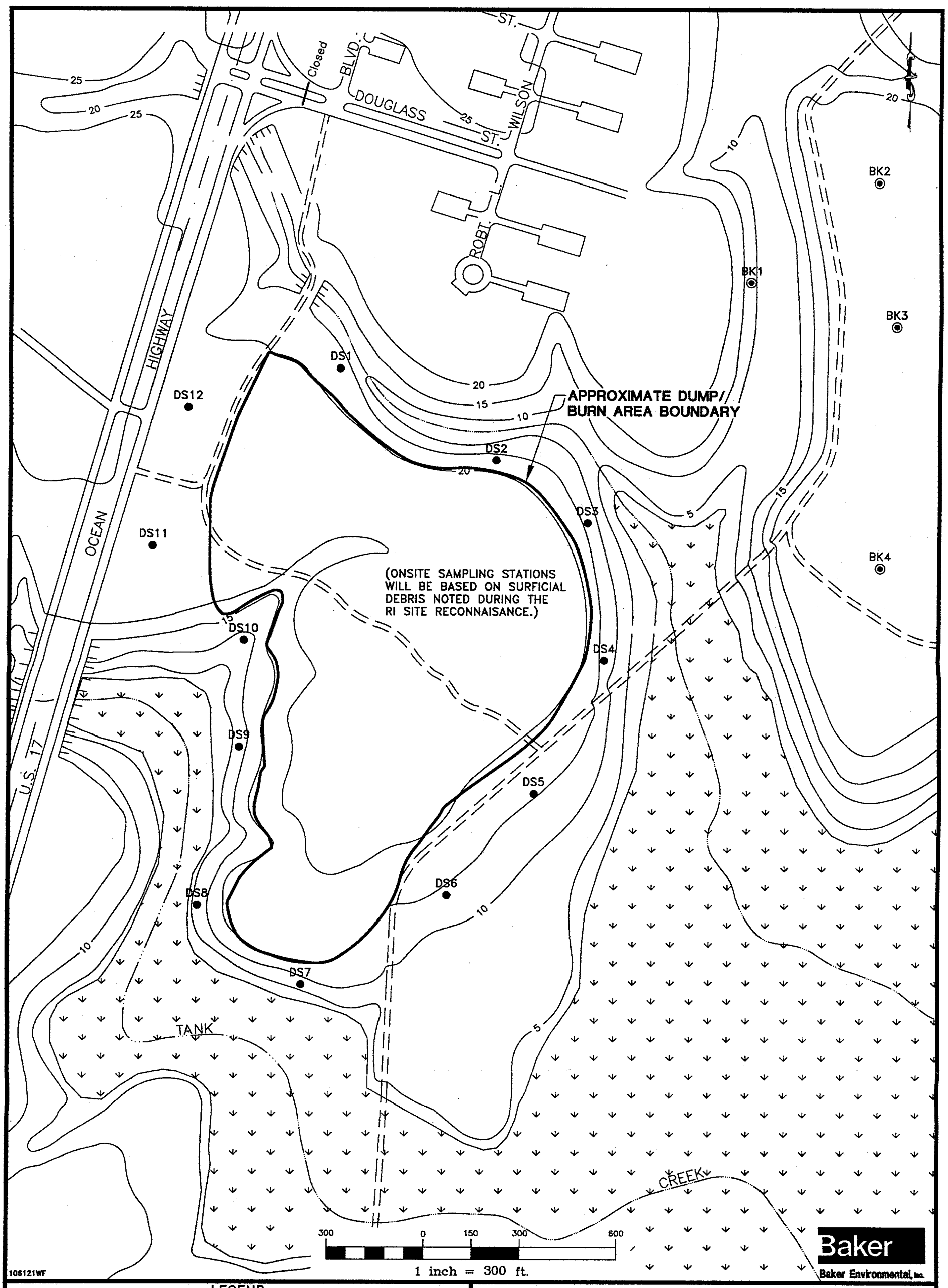
All soil samples will be analyzed for full TCL organics, TAL inorganics, CSM, ordnance constituents and mirex (see Table 5-2).

Characterization of On Site Surface and Subsurface Soil Quality

Areas identified as suspected waste disposal areas via the site reconnaissance and geophysical investigations will be investigated. At each surficial disposal area defined during the site reconnaissance, one surface (0 to 12 inches) and one subsurface soil sample (2-4 feet) will be collected by hand augering. The location will be in the central portion of the surficial debris. Prior to sampling, the location will be cleared for buried ordnance by a subcontractor. If buried metal is detected, only a surface soil sample will be obtained.

Areas identified as possible disposal areas via the geophysical investigations will also be investigated. At each area of concern, test borings will be augered and soil samples collected using ASTM Method D1586-84. The number of test borings will be determined in the field based on the size of the anomaly. The boreholes will be placed to collect soil data to assess the horizontal and vertical extent of contamination. However, borings will not be augered through areas where metallic anomalies are detected due to the potential for encountering ordnance, chemical agents in drums, or flammable materials in drums.

Soil samples will be collected with a split spoon at 2-foot centers until the first 2-foot interval below the water table. The surface soil in the top twelve inches and two subsurface soil samples which are mid-depth and the bottom of borehole, will be submitted for analysis. Due



LEGEND

- DS1 ● – DOWNSLOPE SURFACE SOIL SAMPLING STATION
- BK1 ◉ – BACKGROUND SOIL SAMPLING STATION
- ↓ ↓ – MARSH
- 5 – TOPOGRAPHIC ELEVATION LINES
- ═══ – ROAD (IMPROVED)
- = = = – ROAD (UNIMPROVED)
- ~~~ – INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 5-7
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
SURFACE SOIL SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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to the high water table reported at this site, some boreholes may only produce two soil samples for chemical analysis.

The actual number of borings is unknown. However, for costing purposes, it is estimated that this investigation will involve 25 soil borings. All samples will be analyzed for full TCL organics, TAL inorganics, CSM, mirex, and ordnance constituents (see Table 5-2).

Characterization of Soil in Monitoring Well Boreholes

A minimum of seven shallow boreholes and six intermediate depth boreholes will be drilled for installing monitoring wells at Site 41. Additional boreholes may be augered for subsequent installation of monitoring wells following the evaluation of data collected as part of the geophysical investigations.

Monitoring well test borings will be augered and soil samples collected in accordance with ASTM Method D1586-84. Soil samples will be collected with a split spoon at 2-foot intervals along 2-foot centers to the bottom of the borehole. The shallow boreholes shall be terminated approximately 15 feet below the water table. The intermediate boreholes will be terminated approximately 10 to 15 feet below a clay-limestone-shell formation, which may be encountered approximately 20 to 25 feet below ground surface. This formation is believed to be the upper portion of the Castle Hayne Aquifer.

Soil samples will be collected for chemical analysis from each borehole. The initial 2-foot interval, the approximate middle depth interval, and the interval which encounters the water table will be submitted for full TCL organics and TAL inorganics. In addition, two composite samples (i.e., one composite sample from two borings) will be analyzed for engineering parameters including grain-size analysis and Atterburg Limits.

QA/QC samples include field blanks, duplicates, trip blanks, preservation blanks, and equipment rinsate blanks. Laboratory QA/QC samples include matrix spike (MS) and matrix spike duplicate (MSD) samples.

Field duplicate samples will be collected at a rate of one sample per ten soil samples collected. One trip blank will accompany each day's shipment of samples for volatile organic analysis (i.e., one trip blank for each shipment container with samples for volatile organic analysis). Equipment rinsate blanks will be submitted daily. One field blank will be submitted for the

entire investigation. A sample of the drilling mud, if mud rotary needs to be employed due to site conditions, and bentonite mix will be collected for analysis.

All duplicate samples will be analyzed for the corresponding analysis. Blank QA/QC samples will be analyzed for TCL organics and TAL inorganics. Trip blanks will be analyzed for TCL volatile organics only.

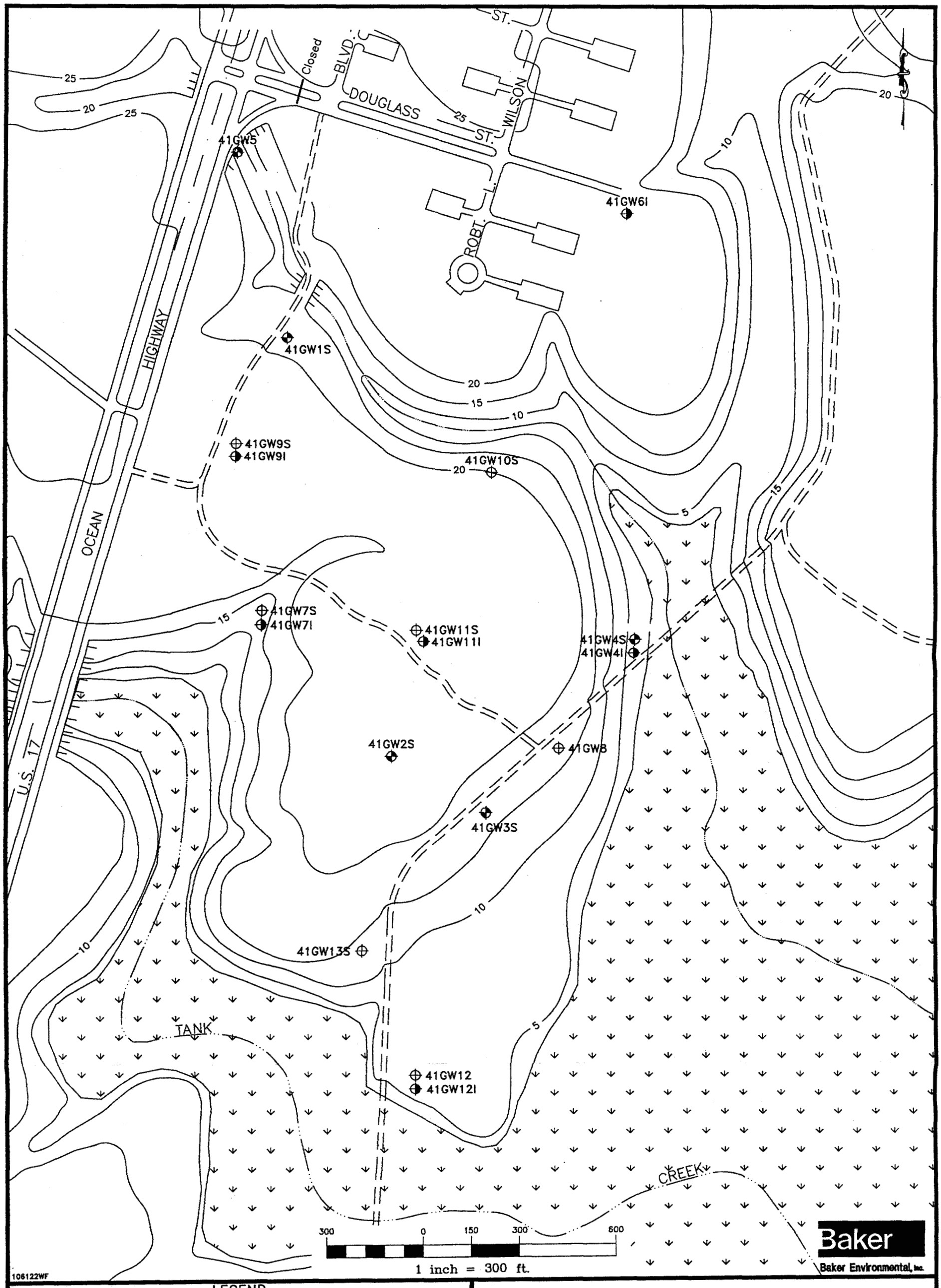
5.3.3.6 Groundwater Investigation

The groundwater investigation will involve the installation of at least seven shallow monitoring wells to assess groundwater quality in the shallow (e.g., water table) aquifer. Six "intermediate" wells will be installed in the shell-limestone formation (i.e., Castle Hayne) to assess vertical and horizontal contaminant migration. One of the six intermediate wells will be installed north of the site in an apparent upgradient location for purposes of assessing background groundwater quality in the Castle Hayne. Existing well 41GW5 will be utilized to assess background groundwater quality in the shallow aquifer.

The proposed well locations are shown on Figure 5-8. Additional shallow or intermediate depth monitoring wells may be installed within the former disposal area following the evaluation of geophysical data in order to determine groundwater quality near former trenches or waste burial areas.

Wells 41GW11S and 41GW11I will be located in what appears to be the center portion of the former disposal area. Currently, there are no wells in this portion of the site. Wells 41GW7S through 41GW10S, and well 41GW12S will be positioned at the edge of the former disposal area to assess horizontal migration of groundwater contamination in the shallow aquifer. The current number of wells along the former disposal area boundary are not sufficient to characterize shallow groundwater quality given the size of the study area. Well 41GW12S, which is located near the wetland, will be constructed to monitor shallow groundwater in an apparent discharge zone.

Intermediate depth wells will be paired with shallow wells 41GW9S, 41GW4S, 41GW7S, 41GW11S, and 41GW12S in order to assess groundwater quality in the deeper Castle Hayne aquifer.



LEGEND

- 41GW1 – EXISTING GROUNDWATER MONITORING WELL
- 41GW7S – PROPOSED SHALLOW MONITORING WELL
- 41GW4I – PROPOSED INTERMEDIATE MONITORING WELL
- MARSH
- 5 – TOPOGRAPHIC ELEVATION LINES
- ROAD (IMPROVED)
- ROAD (UNIMPROVED)
- INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 5-8
SITE 41
CAMP GEIGER DUMP NEAR FORMER TRAILER PARK
PROPOSED SHALLOW AND INTERMEDIATE
MONITORING WELL LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02317S07Z

The monitoring wells will be constructed of 2-inch PVC casing and screen. The screen will be schedule 40 and ten feet in length. The shallow wells will be constructed to a depth of approximately 10 to 15 feet below the top of the water table. The intermediate depth wells will be installed approximately 10 to 15 feet into the shell-limestone formation.

Following proper well development and purging (see FSAP, Section 5.2.3), two rounds of groundwater samples will be obtained for analysis. The first round of samples will be collected approximately one week following well development. The second round will be collected approximately 3 months following the first round. All groundwater samples will be analyzed for full TCL organics, ordnance constituents, mirex, and TAL inorganics (i.e., total and dissolved metals). In addition, one sample from a shallow and intermediate monitoring well will be collected for engineering parameters including microbial count, BOD, TOC, COD, NH_4, total phosphorus, and alkalinity.

The initial round of groundwater samples will be analyzed within 14 days in order to determine whether additional shallow or deeper monitoring wells are required to complete the investigation. If additional wells are required, the number, location, and depth of wells will be discussed with the USEPA and DEHNR in conjunction with the Navy/Marines.

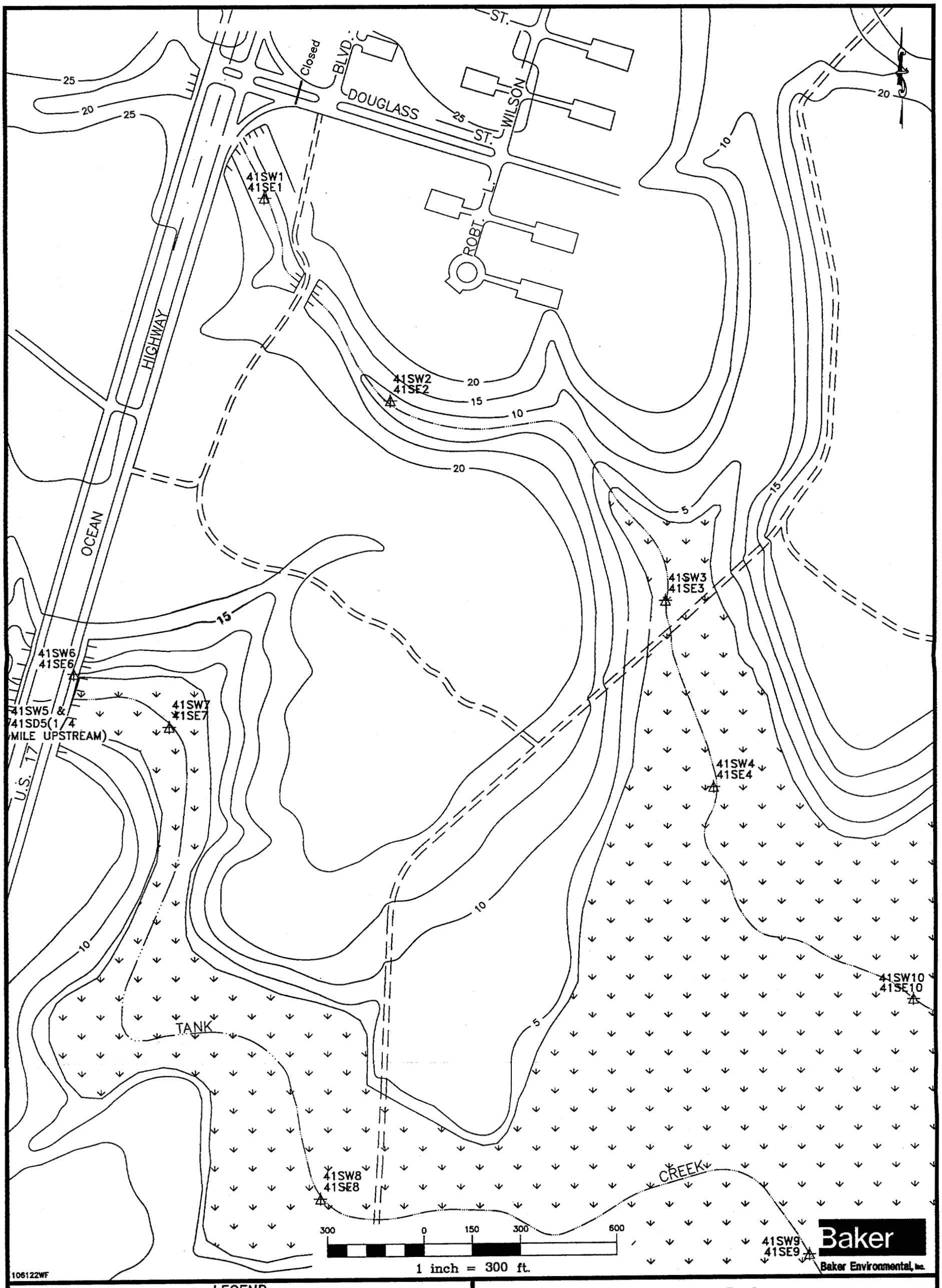
Field measurements will include pH, conductivity, and temperature.

A minimum of two rounds of static water level measurements will also be obtained for determining groundwater flow patterns.

QA/QC samples will consist of field duplicates (e.g., one per ten groundwater samples), equipment rinsate blanks (e.g., one per day), and trip blanks (e.g., one per container containing samples for VOA). Field blanks will be prepared as part of the soil investigation.

5.3.3.7 Surface Water/Sediment Investigation

The unnamed tributary to Southwest Creek and Tank Creek will be investigated. As shown on Figure 5-9, five sampling stations are proposed along both the unnamed tributary and Tank Creek. At each sampling station, a surface (top six inches) and subsurface (6 to 12 inches) sediment sample will be collected for analysis. One surface water sample will be collected at each station.



LEGEND

41SW1 / 41SE1 – PROPOSED SURFACE WATER/SEDIMENT SAMPLING STATIONS

– MARSH

5 – TOPOGRAPHIC ELEVATION LINES

– ROAD (IMPROVED)

– ROAD (UNIMPROVED)

– INTERMITTENT STREAM

SOURCE: LANTDIV, OCT. 1991

FIGURE 5-9
SITE 41
CAMP GEIGER DUMP NEAR
FORMER TRAILER PARK
SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

02317S08Z

All samples will be analyzed for full TCL organics, ordnance constituents, mirex, and TAL inorganics. Field measurements will include pH, conductivity, and temperature.

5.3.4 Investigative Derived Waste Handling

All drill cuttings will be collected and contained in roll-off boxes. One roll-off box will be assigned to each site. One 1,500 gallon tanker will be stationed at each site for containing groundwater purge and development water. A composite soil sample will be collected from each roll-off box and analyzed for full TCL organics, TAL inorganics, TCLP organics and inorganics, reactivity, corrosivity, and ignitability. One water sample will be collected from each tanker and analyzed for full TCL organics and TAL inorganics. Additional details regarding IDW handling and disposal is provided in the FSAP in Section 5.8.

5.4 Task 4 - Sample Analysis and Validation

This task involves efforts relating to the following post-field sampling activities for Sites 69, 74, and 41:

- Sample Management
- Laboratory Analysis
- Data Validation

Sample management activities involve coordination with subcontracted laboratories, tracking of samples submitted for analysis, tracking of analyses received, and tracking of samples submitted and received from a third party validator. Sample management also involves resolving potential problems (e.g., reanalysis, resubmission of information, etc.) between Baker, the laboratory, and the validator.

Laboratory analysis begins when the samples are shipped from the field and received by the laboratory. The cost for analysis are included as part of this task. Subcontracted laboratories under a Baker Basic Ordering Agreement will be utilized.

Validation begins when the "raw" laboratory data is received by the validator from Baker. Baker will first receive the data from the laboratory, log it into a database for tracking purposes, and then forward it to the validator. A validation report will be expected within

four weeks following receipt of laboratory data packages (e.g., Level IV) by the validator. Level IV data will be validated per the CLP criteria as outlined in the following documents:

- National Functional Guidelines for Organic Data Review, USEPA, 1991.
- National Validation Functional Guidelines for Inorganic Data Review, USEPA, 1988.

5.5 Task 5 - Data Evaluation

This task involves efforts related to the data from Sites 69, 74, and 41 once it is received by the laboratory and validated. It also involves the evaluation of any field-generated data including: water level measurements, in-situ permeability tests, test boring logs, and other field notes. Efforts under this task will include the tabulation of validated data and field data, generation of test boring logs and monitoring well construction logs, generation of geologic cross-section diagrams, and the generation of other diagrams associated with field notes or data received from the laboratory (e.g., sampling location maps, isoconcentration maps).

5.6 Task 6 - Risk Assessment

This section of the Work Plan will serve as the guideline for the baseline risk assessments (BRAs) to be conducted for MCB Camp Lejeune during the RI of Sites 69, 74, and 41.

Baseline risk assessments evaluate the potential human health and/or ecological impacts that would occur in the absence of any remedial action. The risk assessment will provide the basis for determining whether or not remedial action is necessary and the justification for performing remedial actions.

The risk assessments will be performed in accordance with USEPA guidelines. The primary documents that will be utilized include:

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A), EPA 1989.

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), EPA 1991.

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives), EPA 1991.

- Risk Assessment Guidance for Superfund: Volume II, Environmental Evaluation Manual, EPA 1989.

- Supplemental Guidance to RAGS: Standard Default Values, EPA 1991a.

- Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992.

- Superfund Exposure Assessment Manual, EPA 1988.

- Exposure Factors Handbook, EPA 1989b.

- Guidance for Data Usability in Risk Assessment, EPA 1990.

- Supplemental Region IV Risk Assessment Guidance, EPA Region IV, 1991.

USEPA Region IV will be consulted for Federal guidance, and the North Carolina DEHNR will be consulted for guidance in the State of North Carolina.

The technical components of the BRA are contaminant identification, exposure assessment, toxicity assessment, and risk characterization. The objectives of the risk assessment process can be accomplished by:

- Characterizing the toxicity and levels of contaminants in relevant media (e.g., groundwater, surface water, soil, sediment, air, and biota).

- Characterizing the environmental fate and transport mechanisms within specific environmental media.

- Identifying potential current and future human and/or environmental receptors.

- Identifying potential exposure routes and the extent of the actual or expected exposure.

- Characterizing current and future potential human health risks.

- Identifying the levels of uncertainty associated with the above items.

As outlined in the Scope of Work, the quantitative BRAs to be performed at MCB Camp Lejeune for Sites 69, 74, and 41 are to utilize all available data to date that has been properly validated in accordance with EPA guidelines plus all data to be collected from additional sampling during this RI.

5.6.1 Human Health Evaluation Process

5.6.1.1 Site Location and Characterization

A background section will be presented at the beginning of each risk assessment to provide an overview of the characteristics of each site. This section will provide a site location, a general site description, and the site-specific chemicals as discussed in past reports. The physical characteristics of the site and the geographical areas of concern will be discussed. This site description will help to characterize the exposure setting.

5.6.1.2 Data Summary

Because decisions regarding data use may influence the resultant risk assessment, careful consideration must be given to the treatment of those data. For purposes of risk evaluation, the sites at MCB Camp Lejeune may be partitioned into zones or operable units for which chemical concentrations will be characterized and risks will be evaluated. Sites will be grouped into operable units if they are close to one another, have similar contamination, and/or may impact the same potential receptors. In selecting data to include in the risk assessment, the objective is to characterize, as accurately as possible, the distribution and concentration of chemicals in each operable unit.

Data summary tables will be developed for each medium sampled (e.g., surface water, sediment, groundwater, soil). Each data summary table will indicate the frequency of detection, observed range of concentrations (i.e., minimum and maximum concentration level), and the means and upper 95 percent confidence limit value for each contaminant detected in each medium. The arithmetic or geometric mean and the upper 95 percent confidence limit of that mean will be used in the summary of potential chemical data. The

selection of arithmetic or geometric means will depend on whether the sample data are normally or lognormally distributed. In the calculation of the mean, concentrations presented as "ND" (nondetect) will be incorporated at one-half the sample quantitation limit (SQL). If SQLs cannot be obtained, then use one-half the Contract Required Detection Limits (CRQL), Method Detection Limit (MDL), or Instrument Detection Limit (IDL), in that order, with caution provided the number of non-detects is not greater than 10 to 15 percent of the data. The substituted values on the data summary tables will be clearly defined. Due to the size of the analytical database data frequency and statistical summaries may need to be presented in an appendix.

5.6.1.3 Identifying Chemicals of Potential Concern

The criteria to be used in selecting the Contaminants of Potential Concern (COPCs) from the constituents detected during the sampling and analytical phase of the investigation are: historical information, prevalence, mobility, persistence, toxicity, comparison of the ARARs, comparison to blank data or base-specific naturally occurring levels (i.e., background), and comparison to anthropogenic levels. These criterion chosen to establish the COPCs are derived from the USEPA's Risk Assessment Guidance for Superfund (USEPA, 1989).

The two times background soil concentration "rule of thumb" will be used in the selection of inorganic COPCs. In this evaluation base-specific and literature values will be used to warrant the elimination or retention of inorganics.

All of the available sample data will undergo review upon initiation of the risk assessment. Common laboratory contaminants such as acetone, methylene chloride, phthalate esters, toluene, and methyl ethyl ketone will be addressed only if concentrations are 10 times greater than the corresponding blanks. In addition, chemicals that are not common laboratory contaminants will be evaluated if they are greater than five times the laboratory blank. The number of chemicals analyzed in the risk assessment will be a subset of the total number of chemicals detected at a site based on the elimination criteria discussed previously.

Tables will be prepared that list chemical concentrations for all media by site. Data will be further grouped according to organic, inorganic, and chemical surety degradation compounds within each table.

5.6.1.4 Exposure Assessment

The objectives of the exposure assessment at MCB Camp Lejeune will be to characterize the exposure setting, identify exposure pathways, and quantify the exposure. When characterizing the exposure setting, the potentially exposed populations will be described. The exposure pathway will identify: the source and the mechanism of medium for the released chemical (e.g., groundwater), the point of potential human contact with the contaminated medium, and the exposure route(s) (e.g., ingestion). The magnitude, frequency, and duration for each exposure pathway identified will be quantified during this process.

The identification of potential exposure pathways at the two sites will include the activities described in the subsections that follow.

Analysis of the Probable Fate and Transport of Site- Specific Chemicals

To determine the environmental fate and transport of the chemicals of concern at the site, the physical/chemical and environmental fate properties of the chemicals will be reviewed. Some of these properties include volatility, photolysis, hydrolysis, oxidation, reduction, biodegradation, accumulation, persistence, and migration potential. This information will assist in predicting potential current and future exposures. It will help in determining those media that are currently receiving site-related chemicals or may receive site-related chemicals in the future. Sources that may be consulted in obtaining this information include computer databases (e.g., AQUIRE, ENVIROFATE), as well as available literature.

The evaluation of fate and transport may be necessary where the potential for changes in future chemical characteristics is likely and for those media where site-specific data on the chemical distribution is lacking.

Identification of Potentially Exposed Human Populations

Human populations, that may be potentially exposed to chemicals at the MCB Camp Lejeune, include base personnel and their families, base visitors, and on site workers and recreational fishermen/women. Hunting is permitted in some areas of the base (near Sites 41 and 74, but not near Site 69). The Base Master Plan will be consulted to confirm or modify these potential exposures. Nonworking residents who might be exposed to site-specific chemicals could include spouses and/or children of base personnel and resident workers. Resident and

nonresident workers could be exposed to chemicals as they carry out activities at any of the sites located at MCB Camp Lejeune. The list of potential receptors and pathways to be evaluated will be refined during discussions with regulators prior to performing the BRA.

Identification of Potential Exposure Scenarios Under Current and Future Land Uses

The exposure scenarios will be finalized after consulting with the Base Master Plan, EPA and the State of North Carolina. Generally, exposure pathways will be considered preliminarily as follows:

- Soil Pathway
  - Incidental ingestion (current military personnel, future resident, current and future recreational users)
  - Inhalation of dust (current military personnel, future resident, current and future recreational users)
  - Dermal contact (current military personnel, future resident, current and future recreational users)

- Sediment Pathway
  - Dermal contact and incidental (current military personnel, future resident, current and future recreational users)

- Surface Water
  - Dermal contact (current military personnel, future resident, current and future recreational users)
  - Ingestion of contaminated fish (current military personnel, future resident, current and future recreational users)

- Groundwater (future potential only)
  - Direct ingestion (base personnel, on site residents, on site workers, visitors)
  - Inhalation (base personnel, on site residents, on site workers, visitors)
  - Dermal contact (base personnel, on-site residents, on-site workers, visitors)

- Biota
  - Ingestion of fish or shellfish (current military personnel, future resident, current and future recreational users)

Exposure Point Concentrations

After the potential exposure points and potential receptors have been defined, exposure point concentrations must be calculated. The chemical concentrations at these contact points are critical in determining intake and, consequently, risk to the receptor. The data from site investigations will be used to estimate exposure point concentrations.

The means and the upper 95 percent upper confidence limits (95% UCL) of the means will be used throughout the risk assessment. If the data are lognormally distributed, the means will be based on the geometric mean rather than the arithmetic mean. If there is great variability in measured or modeled concentration values (i.e., too few samples are collected to estimate a statistically relevant mean concentration) the 95% UCL on the average concentration or geometric mean will be high, and conceivably could be above the maximum detected or modeled concentration. In cases like these, although thought to be too conservative, the maximum value will be used to estimate potential exposure.

Exposure doses will be estimated for each exposure scenario from chemical concentrations at the point of contact by applying factors that account for contact frequency, contact duration, average body weight, and other route-specific factors such as breathing rate (e.g., inhalation). These factors will be incorporated into exposure algorithms that convert the environmental concentrations into chronic daily intakes. Intakes will be reported in milligrams of chemical taken in by the receptor (i.e., ingested, inhaled, etc.) per kilogram body weight per day (mg/kg/day). Intakes for potentially exposed populations will be calculated separately for the appropriate exposure routes and chemicals.

5.6.1.5 Toxicity Assessment

Toxicity values (i.e., numerical values derived from dose-response toxicity data for individual compounds) will be used in conjunction with the intake determinations to characterize risk. Toxicity values will be obtained from the most recent versions of the following sources:

- Integrated Risk Information System (IRIS) - The principal toxicology database, which provides updated information from USEPA on cancer slope factors, reference doses, and other standards and criteria for numerous chemicals.

- Health Effects Assessment Summary Tables (HEAST) - A comprehensive listing of provisional risk assessment information relative to oral and inhalation routes.

For some chemicals, toxicity values (i.e., reference doses) may have to be derived if the principal references previously mentioned do not contain the required information. These derivations will be provided in the risk assessment for review by USEPA Region IV. The toxicity assessment will include a brief description of the studies on which selected toxicity values were based, the uncertainty factors used to calculate noncarcinogenic reference doses

(RfDs), the USEPA weight-of-evidence classification for carcinogens, and their respective slope factors.

5.6.1.6 Risk Characterization

Risk characterization involves the integration of exposure doses and toxicity information to quantitatively estimate the risk of adverse health effects. Quantitative risk estimates based on the reasonable maximum exposures to the site contaminants will be calculated based on available information. For each exposure scenario, the potential risk for each chemical will be based on intakes from all appropriate exposure routes. Carcinogenic risk and noncarcinogenic hazard indices are assumed to be additive across all exposure pathways and across all of the chemicals of concern for each exposure scenario. Potential carcinogenic risks will be evaluated separately from potential noncarcinogenic effects, as discussed in the following subsections.

Carcinogenic Risk

For the potential carcinogens that are present at the site, the carcinogenic slope factor (q_1^*) will be used to estimate cancer risks at low dose levels. Risk will be directly related to intake at low levels of exposure. Expressed as an equation, the model for a particular exposure route is:

$$\text{Excess lifetime cancer risk} = \text{Estimated dose x carcinogenic slope factor; or CDI x } q_1^*$$

Where: CDI = Chronic daily intake

This equation is valid only for risk less than 10^{-2} (1 in 100) because of the assumption of low dose linearity. For sites where this model estimates carcinogenic risks of 10^{-2} or higher, an alternative model will be used to estimate cancer risks as shown in the following equation:

$$\text{Excess lifetime cancer risk} = 1 - \exp(-\text{CDI} \times q_1^*)$$

Where: exp = the exponential

For quantitative estimation of risk, it will be assumed that cancer risks from various exposure routes are additive. Since there are no mathematical models that adequately describe antagonism or synergism, these issues will be discussed in narrative fashion in the uncertainty analysis.

Noncarcinogenic Risk

To assess noncarcinogenic risk, estimated daily intakes will be compared with reference doses RfD for each chemical of concern. The potential hazard for individual chemicals will be presented as a hazard quotient (HQ). A hazard quotient for a particular chemical through a given exposure route is the ratio of the estimated daily intake and the applicable RfD, as shown in the following equation:

$$HQ = EDI/RfD$$

Where: HQ = Hazard quotient
EDI = Estimated daily intake or exposure (mg/kg/day)
RfD = Reference dose (mg/kg/day)

To account for the additivity of noncarcinogenic risk following exposure to numerous chemicals through a variety of exposure routes, a hazard index (HI), which is the sum of all the hazard quotients, will be calculated. Ratios greater than one, or unity, indicate the potential for adverse effects to occur. Ratios less than one indicate that adverse effects are unlikely. This procedure assumes that the risks from exposure to multiple chemicals are additive, an assumption that is probably valid for compounds that have the same target organ or cause the same toxic effect. In some cases when the HI exceeds unity it may be appropriate to segregate effects, as expressed by the HI, by target organ since those effects would not be additive. As previously mentioned, where information is available about the antagonism or synergism of chemical mixtures, it will be appropriately discussed in the uncertainty analysis.

5.6.1.7 Uncertainty Analysis

There is uncertainty associated with any risk assessment. The exposure modeling can produce very divergent results unless standardized assumptions are used and the possible variation in others are clearly understood. Similarly, toxicological assumptions, such as extrapolating from chronic animal studies to human populations, also introduce a great deal of uncertainty

into the risk assessment. Uncertainty in a risk assessment may arise from many sources including:

- Environmental chemistry sampling and analysis.
- Misidentification or failure to be all-inclusive in chemical identification.
- Choice of models and input parameters in exposure assessment and fate and transport modeling.
- Choice of models or evaluation of toxicological data in dose-response quantification.
- Assumptions concerning exposure scenarios and population distributions.

The variation of any factor used in the calculation of the exposure concentration will have an impact on the total carcinogenic and noncarcinogenic risk. The uncertainty analysis will qualitatively discuss non-site and site-specific factors that may product uncertainty in the risk assessment. These factors may include key modeling assumptions, exposure factors, assumptions inherent in the development of toxicological end points, and spatio-temporal variance in sampling.

5.6.2 Ecological Risk Assessment

5.6.2.1 Purpose and Approach

The overall purpose of an ecological risk assessment is to evaluate the likelihood that adverse ecological effects would occur or are occurring as a result of exposure to one or more physical or chemical stressors. The proposed evaluation will focus on identifying potential adverse effects of area-specific contamination on the ecological integrity of the terrestrial and aquatic receptors (e.g., flora and fauna) on, or adjacent to, each site, or group of sites (e.g, operable unit), at MCB Camp Lejeune. In addition, this assessment will evaluate the potential effects of contaminants on sensitive environments including wetlands, protected species, critical habitats, and breeding/nursery areas. If potential risks are characterized for the ecological receptors, further ecological evaluation of the site and surrounding areas may be warranted.

The technical approach used in this ecological risk assessment parallels that used in the human health risk assessment; however, since the protocols for evaluating the ecological risks have not been sufficiently developed, the ecological risk assessment may be more qualitative than its human health counterpart. The results of the ecological risk assessment will be used in conjunction with the human health risk assessment in order to determine the appropriate remedial action at this site for the overall protection of public health and the environment.

The risk assessment methodologies to be used in this evaluation are consistent with those outlined in the Framework for Ecological Risk Assessment, which was developed by the USEPA in 1992. In addition, information found in the following documents will be used to supplement the USEPA guidance document:

USEPA Risk Assessment Guidance for Superfund - Volume II, Environmental Evaluation Manual (USEPA, 1989)

Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (USEPA, 1989)

Rapid Bioassessment Protocols for use in Streams and Rivers: Benthic Macroinvertebrates and Fish (USEPA, 1989)

The subsections that follow describe the general technical approach proposed to evaluate the likelihood that adverse ecological effects would occur or are occurring as a result of exposure to one or more physical or chemical stressors found at MCB Camp Lejeune. The ecological risk assessment will consist of three main components: (1) Problem Formulation, (2) Analysis, and (3) Risk Characterization. The problem formulation section includes a preliminary characterization of exposure and effects of the stressors to the ecological receptors. During the analysis, the data is evaluated to determine the exposure and potential effects of the ecological receptors from the stressors. Finally, in the risk characterization, the likelihood of adverse effects occurring as a result of exposure to a stressor are evaluated. This component or step evaluates the potential impact on the ecological integrity at the site from the contaminants detected in the various environmental media.

5.6.2.1 Problem Formulation

Problem formulation is the first step of an ecological risk assessment and includes a preliminary characterization of exposure and effects, as well as scientific data needs, policy and regulatory issues, and site-specific factors to define feasibility, scope, and objectives. The components of the problem formulation phase consist of: stressor characteristics, ecosystems potentially at risk; ecological effects; endpoint selection; and, a conceptual model.

Stressor Characteristics

One of the initial steps in the problem formulation stage is to identify the physical and chemical stressor characteristics. Physical stressors include extremes of natural conditions (e.g., temperature and hydrologic changes) and habitat alteration or destruction. For the chemical stressors, the selection of contaminants of concern will be based on frequency of detection, background comparison, persistence of the contaminant, bioaccumulation potential, and the toxicity of the contaminant. Because of the differential toxicity of some contaminants to ecological versus human receptors, the contaminants of concern for ecological receptors may differ from those selected for the human health risk assessment.

Ecosystem Potentially at Risk

Based on available regional and site-specific ecology, the ecosystem within which effects from stressors would occur or are occurring is evaluated and ecological receptors that potentially are at risk are identified. This stressor-ecosystem-receptor relationship will be used to develop exposure scenarios in the analysis phase. Properties of the ecosystem used in this evaluation include a biotic environment (e.g., climatic conditions and soil or sediment properties), ecosystem structure (e.g., abundance and trophic level relationships), and ecosystem function (e.g., energy source, energy utilization, and nutrient processing). In addition, the types and patterns of historical disturbances are used to predict ecological receptor-stressor responses. Finally, spatial and temporal distribution is used to define the natural variability in the ecosystem.

Selection of the ecological components for evaluation in the ecological risk assessment will be based on the following factors:

- The nature of the stressor and the potential for the stressor to interact with the ecological component

- The value of the ecological component from an ecological or ecosystem perspective
- The value of the ecological component from a human perspective
- Rare, threatened, or endangered species
- Species of commercial or recreational importance

The potential for indirect effects will be considered in the selection of ecosystem components for evaluation. Indirect or secondary effects can include reduction in prey availability or habitat utilization.

Ecological Effects

Ecological effects data will be compiled for the physical and chemical stressors identified. Ecological effects data may come from a variety of sources including field observations (e.g., fish or bird kills, changes in community structure), field tests (e.g., micro/meso-cosm tests), laboratory tests (e.g., bioassays), and chemical structure-activity relationships. Considerations will be given to the extrapolation required for application of laboratory-based test to field situations and to the interpretation of field observations that may be influenced by natural variability or non-site stressor that are not the focus of the ecological risk assessment.

Endpoint Selection

The information compiled during the first stage of problem formulation (i.e., stressor characteristics, ecosystems potentially at risk, and ecological effects) will be used to select ecological endpoints, defined as assessment endpoints and measurement endpoints, that will be used in the ecological risk assessment. An endpoint is a characteristic of an ecological component that may be affected by exposure to a stressor. The assessment endpoints are expressions of the actual environmental value that is to be protected. Measurement endpoints are measurable responses to a stressor that are related to the valued characteristic chosen as the assessment endpoint. The endpoints can be further divided into four primary ecological groups: individual; population; community; and, ecosystem ecological endpoints.

Conceptual Model

The conceptual model consist of a series of working hypotheses regarding how the stressor might affect ecological components of the ecosystem potentially at risk. The conceptual model is the summation of the preliminary analysis conducted pursuant to the problem formulation phase of the ecological risk assessment.

5.6.2.2 Analysis - Characterization of Exposure

The interaction of the stressor with the ecological component will be evaluated in the characterization of exposure. An exposure pathway is developed that quantifies the magnitude and spatial and temporal distributions of exposure for the various ecological components selected during the problem formulation and serves as input to the risk characterization. The components of the characterization of exposure phase consist of: stressor characterization, ecosystem characterization; exposure analysis; and exposure profile.

Stressor Characterization

The distribution or pattern of change of the stressor will be determined. For chemical stressors, a combination of modeling and monitoring data will be used to estimate or measure, respectively, releases into the environment and media concentrations over space and time. For physical stressors, the pattern of change will be dependent on historical information such as resource management, land-use practices, or climatic conditions. The timing of the stressor's interaction with the affected component of the ecosystem will be considered. If the stressor is episodic in nature, different species and life stages may be affected. In addition, heterogeneity of stressor distribution will be quantified, where possible.

Ecosystem Characterization

The spatial and temporal distribution of the ecological components will be characterized including a discussion of the regional ecology, site-specific ecology, and sensitive environments on and adjacent to the site. This evaluation will include a literature search to compile the available information on the populations, communities, and habitats in the potentially affected area.

Exposure Analysis/Profile

The spatial and temporal distributions of both the ecological component and the stressor will be combined to evaluate the exposure. Potential exposure scenarios will be developed for each of the environmental media including surface soils, surface water, sediments, and biota. For chemical stressors, the exposure analysis will focus on the amount of the chemical that is bioavailable through uptake as well as actual contact with the stressor. For physical stressors, the focus will be on co-occurrence with the alteration to the community or ecosystem. The information developed in the exposure analysis will be quantified in the exposure profile. For chemical stressors, the exposure profile will be expressed as dose units (i.e., estimated daily intakes) and exposure point concentrations. For physical stressor, the exposure profile will be expressed as magnitude of events per time.

5.6.2.3 Analysis - Characterization of Ecological Effects

The relationship between the stressors and the assessment and measurement endpoints identified during problem formulation will be quantified and summarized in a stressor-response profile. The stressor-response profile will be used as input to the risk characterization. Scientific literature and regulatory guidelines will be reviewed for media-specific and/or species specific toxicity data. On-line databases will be accessed, such as AQUIRE and PHYTOTOX, to obtain current stressor-response data. Toxicity values will be from the most closely related species, where possible. Reference areas will be compared to the potentially affected areas as a basis for characterizing effects.

5.6.2.4 Risk Characterization

Risk characterization is the final phase of the ecological risk assessment and uses the results of the exposure and ecological effects analyses. The likelihood of adverse effects occurring as a result of exposure to a stressor will be evaluated. To integrate the results of the exposure and ecological effects analyses, single effects and exposure values will be compared using the quotient method for both media exposure and uptake exposure. If the ratio exceeds one, some potential for risk is presumed. In addition, risks to communities will be assessed by considering species representation by trophic group, taxa, or habitat.

The ecological significance of the risks with consideration of the types and magnitudes of the effects and their spatial and temporal patterns will be discussed. Ecologically significant risks

can be defined as those potential adverse risks or impacts to ecological integrity that affect populations, communities, and ecosystems, rather than individuals (i.e. measured impacts to individuals does not necessarily indicate impacts to the ecosystem). However, ecological risk assessments are seldom probabilistic in nature (i.e., the probability of an adverse effect is difficult to quantify as a numeric risk estimate). Therefore, unless the risk assessment can be strictly limited to comparisons with existing ecological quality criteria, the characterization of ecological risk will consist of a weight-of-evidence evaluation. The risk characterization component is therefore defined by either the presence of an adverse impact based on actual measurements, or the likelihood of an impact based on extrapolation from field or laboratory measurements or the scientific literature. The weight-of-evidence approach is used to approximate the risk based on the combination of empirical observations and inferences founded in reasonable scientific judgment.

5.6.2.5 Uncertainty Analysis

An ecological risk assessment, like a human health risk assessment, is subject to a wide variety of uncertainties. Virtually every step in the risk assessment process involves numerous assumptions that contribute to the total uncertainty in the final evaluation of risk. Assumptions are made in the exposure assessment regarding potential for exposure and exposure point locations. An effort is made to use assumptions that are conservative, yet realistic. The interpretation and application of ecological effects data is probably the greatest source of uncertainty in the ecological risk assessment. The uncertainty analysis will attempt to address the factors that affect the results of the ecological risk assessment.

5.7 Task 7 - Treatability Study/Pilot Testing

This task includes the efforts to prepare and conduct bench-scale or pilot-scale treatability studies should they be required to support the evaluation of remedial alternatives or the design of the remedial action. The following activities may be conducted:

- Determination of treatability studies required for the project.
- Preparation of Treatability Study Project Plans.
- Test facility and equipment procurement.
- Vendor and analytical services procurement.
- Collection of representative field samples.
- Performance of bench- or pilot-scale treatability studies.

- Evaluation of results.
- Report preparation.

Based on the preliminary information pertaining to Sites 69, 74,and 41 no treatability studies are planned at this time. Available soil and groundwater data at Sites 74 and 41 do not indicate a significant problem that would require treatability studies. Should the RI data indicate otherwise, treatability studies will be considered.

Because the wastes buried at Site 69 will not be addressed from the standpoint of characterization/identification, no soil treatability studies are proposed. Should the surficial soils exhibit contamination requiring treatment, treatability studies may be required. Groundwater at Site 69 is contaminated with VOCs and low levels of inorganics; however, vendor and historical information on the performance of remedial technologies to treat VOC groundwater contamination is sufficient to evaluate remedial alternatives.

5.8 Task 8 - Remedial Investigation Report

This task is intended to cover all work efforts related to the preparation of the findings once the data have been evaluated under Tasks 5 and 6. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final RI report. Because of the complexities of the sites and the amount of information that will be generated, it is proposed that three reports will be generated. These reports will independently address the following:

- Site 69 - Rifle Range Chemical Dump
- Site 74 - Mess Hall Grease Disposal Area
- Site 41 - Camp Geiger Dump near former trailer park

This task ends when the Final RI reports are submitted.

5.9 Task 9 - Remedial Alternatives Screening

This task includes the efforts to select the alternatives to undergo full evaluation. The task begins during data evaluation when sufficient data are available to initiate the screening of potential technologies. For reporting and tracking purposes, the task is defined as complete when a final set of alternatives is chosen for detailed evaluation.

5.10 Task 10 - Remedial Alternatives Evaluation

This task involves the detailed analysis and comparison of alternatives using the following criteria:

- Threshold Criteria:
  - Overall Protection of Human Health and the Environment
  - Compliance With ARARs
- Primary Balancing Criteria:
  - Long-Term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility, and Volume Through Treatment
  - Short-Term Effectiveness
  - Implementability
  - Cost
- Modifying Criteria:
  - State and EPA Acceptance
  - Community Acceptance

5.11 Task 11 - Feasibility Study Report

This task involves reporting the findings of the Feasibility Study. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final FS report. Because of the complexities of the sites and the amount of information that will be generated, it is proposed that three reports will be generated. These reports will independently address the following:

- Site 69 - Rifle Range Chemical Dump
- Site 74 - Mess Hall Grease Disposal Area
- Site 41 - Camp Geiger Dump Near Former Trailer Park

This task ends when the Final FS reports are submitted.

5.12 Task 12 - Post RI/FS Support

This task involves the technical and administrative support to LANTDIV to prepare a Draft, Draft Final, and Final Responsiveness Summary, Proposed Remedial Action Plan, and Record of Decision. These reports will be prepared using applicable USEPA guidance documents.

5.13 Task 13 - Meetings

This task involves providing technical support to LANTDIV during the RI/FS. It is anticipated that the following meetings will be required:

- Meeting between Baker and LANTDIV to discuss the RI and risk assessment following submission of the preliminary draft RI report.
- Meeting between Baker and LANTDIV to discuss the FS following submission of the preliminary draft FS report.
- Technical Review Committee (TRC) meeting to present the results of the RI/FS.
- Public meeting to present the proposed remedial alternatives.

5.14 Task 14 - Community Relations

This task involves providing support to LANTDIV during the various public meetings identified under Task 13. This support includes the preparation of fact sheets, slides, overheads, meeting minutes, coordination with MCB Camp Lejeune Environmental Management Division (EMD) in contacting local officials and media, and the procurement of a stenographer.

6.0 PROJECT MANAGEMENT AND STAFFING

The proposed management and staffing of this RI/FS is depicted in Figure 6-1. The primary participants for this project include:

- Mr. Raymond P. Wattras, Project Manager
- Mr. John Barone, P.G., QA/QC
- (to be determined), Project Geologist
- Ms. Tammi Halapin, Project Engineer
- Mr. Matthew Bartman, Risk Assessment
- Mr. Pete Monday, Site Manager
- Mr. John Lovely, Laboratory Coordinator
- Mr. Ronald Krivan, Health and Safety Officer
- Ms. Melissa C. Davidson, Community Relations Specialist

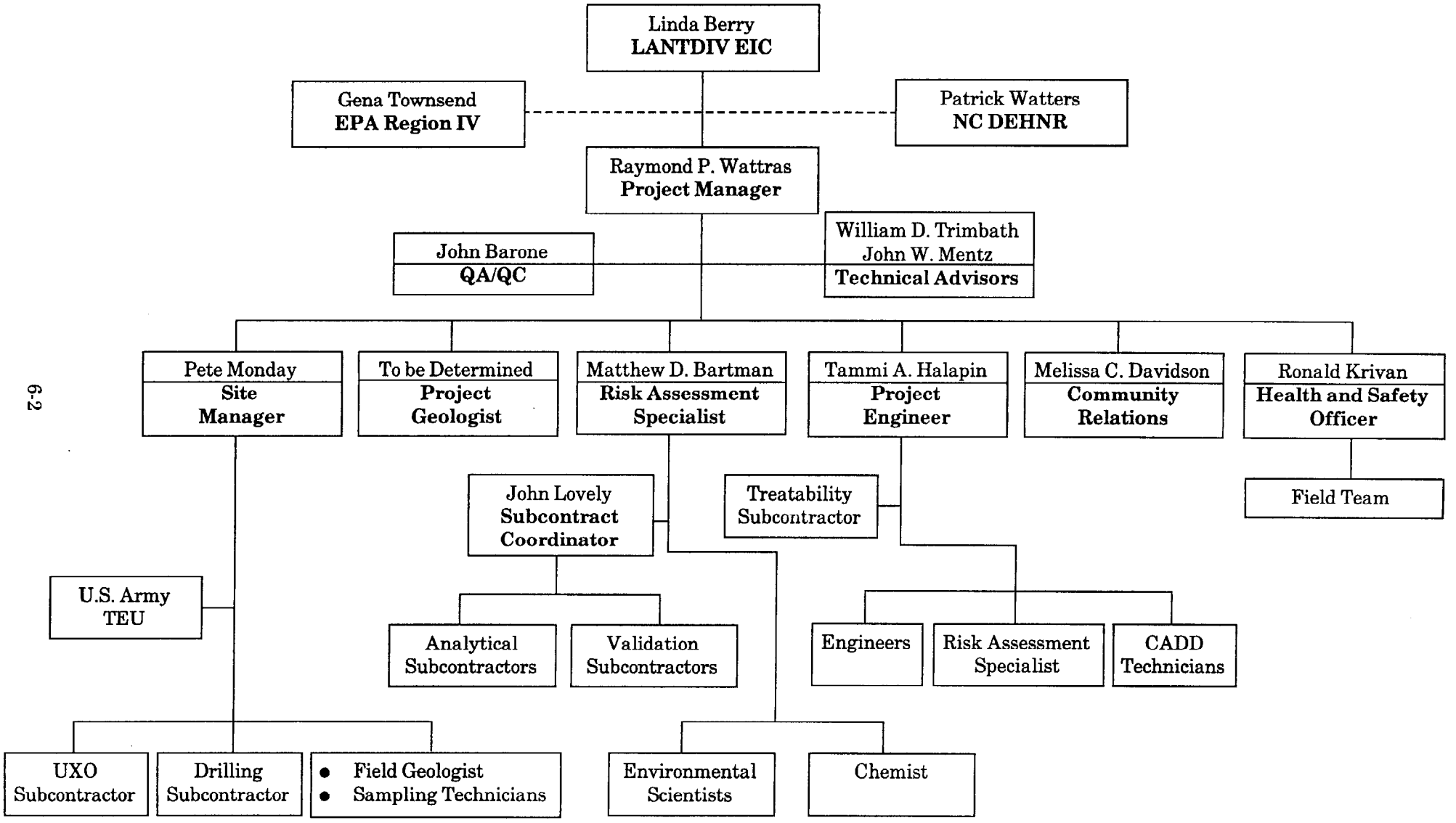
The field portion of this project will consist of two field teams. Each field team will consist of a geologist and sampling technician. Both field teams will report to the Site Manager, who will be responsible for implementing the field tasks. A site health and safety officer will also be on site during the RI field investigations.

From a responsibility and coordination standpoint, the Project Geologist (to be determined) and Mr. Matthew Bartman will have the overall responsibility of completing the three separate RI reports. Ms. Tammi Halapin will be responsible for overseeing the preparation of the three FS reports. These personnel will report directly to the Project Manager. They will be supported by geologists, engineers, biologists, chemists, data technicians, and clerical personnel.

Overall field and reporting QA/QC will be the responsibility of Mr. John Barone. Mr. William D. Trimbath, P.E. and Mr. John W. Mentz will provide Program-level technical and administrative support.

FIGURE 6-1

PROJECT ORGANIZATION
RI/FS AT SITES 69, 74, AND 41
MCB CAMP LEJEUNE, NORTH CAROLINA



7.0 SCHEDULE

The proposed schedule for this project is presented in Figure 7-1. This schedule is based on the Fiscal Year 1994 Site Management Plan (FY94 SMP) for MCB Camp Lejeune, North Carolina. The FY94 SMP is based on the requirements established in the Federal Facilities Agreement between the Navy/Marine Corps, USEPA Region IV, and the North Carolina DEHNR.

Figure 7-2 is the "expedited schedule." The expedited schedule is a non-contractual schedule that is reflective of a goal to complete the RI/FS in an expedited fashion.

Figure 7 - 1: Site Management Schedule

Sites 41, 69 and 74 (Operable Unit No. 4), MCB Camp Lejeune, North Carolina

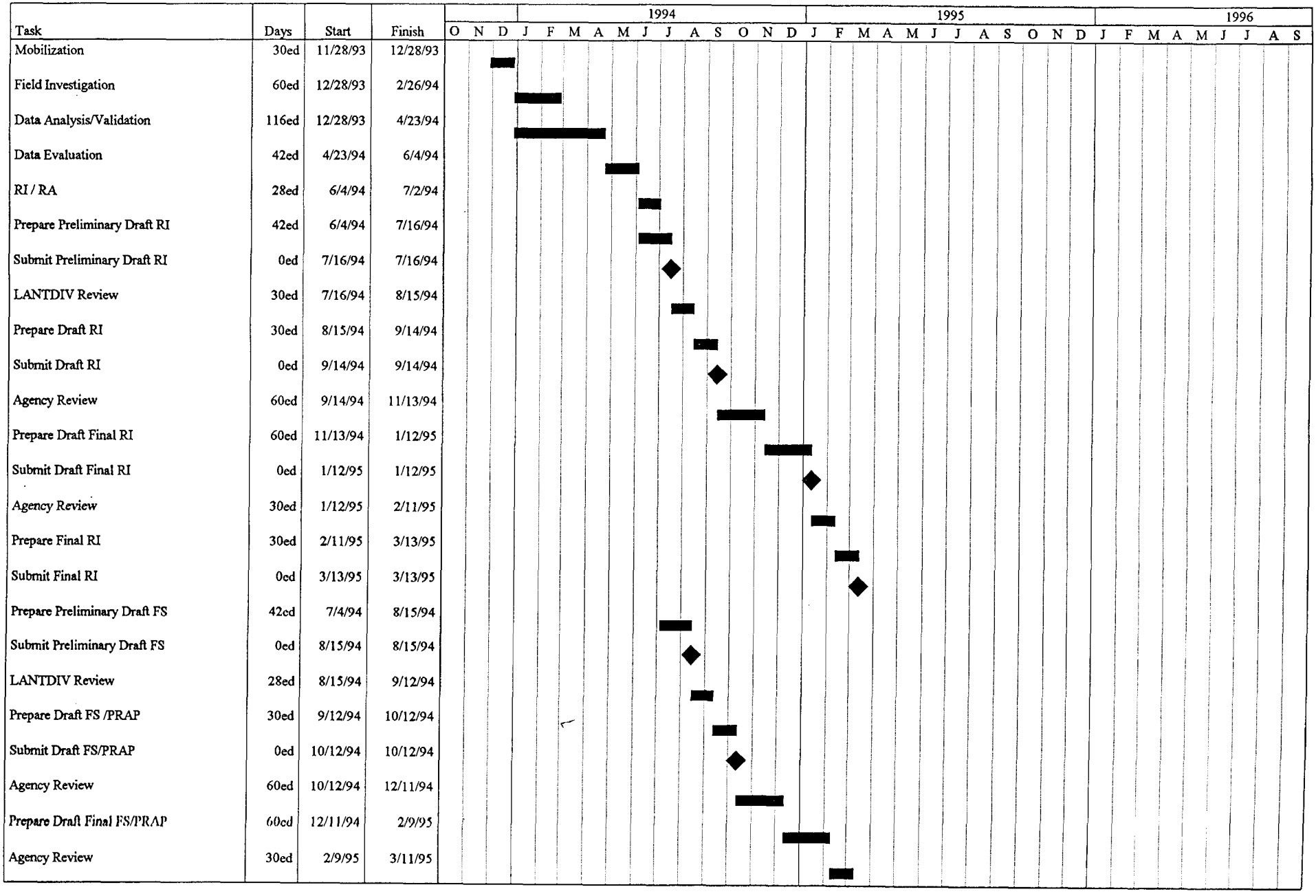


Figure 7 - 1: Site Management Schedule

Sites 41, 69 and 74 (Operable Unit No. 4), MCB Camp Lejeune, North Carolina

Task	Days	Start	Finish
Prepare Final FS/PRAP	30ed	3/11/95	4/10/95
Public Comment Period	30ed	4/10/95	5/10/95
ROD	244ed	9/22/94	5/24/95
Prepare Preliminary Draft ROD	30ed	9/22/94	10/22/94
Submit Preliminary Draft ROD	0ed	10/22/94	10/22/94
LANTDIV Review	21ed	10/22/94	11/12/94
Prepare Draft ROD	14ed	11/12/94	11/26/94
Submit Draft ROD	0ed	11/26/94	11/26/94
Agency Review	59ed	11/26/94	1/24/95
Prepare Draft Final ROD	60ed	1/24/95	3/25/95
Submit Draft Final ROD	0ed	3/25/95	3/25/95
Agency Review	30ed	3/25/95	4/24/95
Prepare Final ROD	30ed	4/24/95	5/24/95
Submit Final ROD	0ed	5/24/95	5/24/95
Remedial Design (1,2)	398ed	5/24/95	6/25/96
Procure RA Contractor (1,2)	60ed	6/25/96	8/24/96
Remedial Action (1,2)	0ed	8/24/96	8/24/96

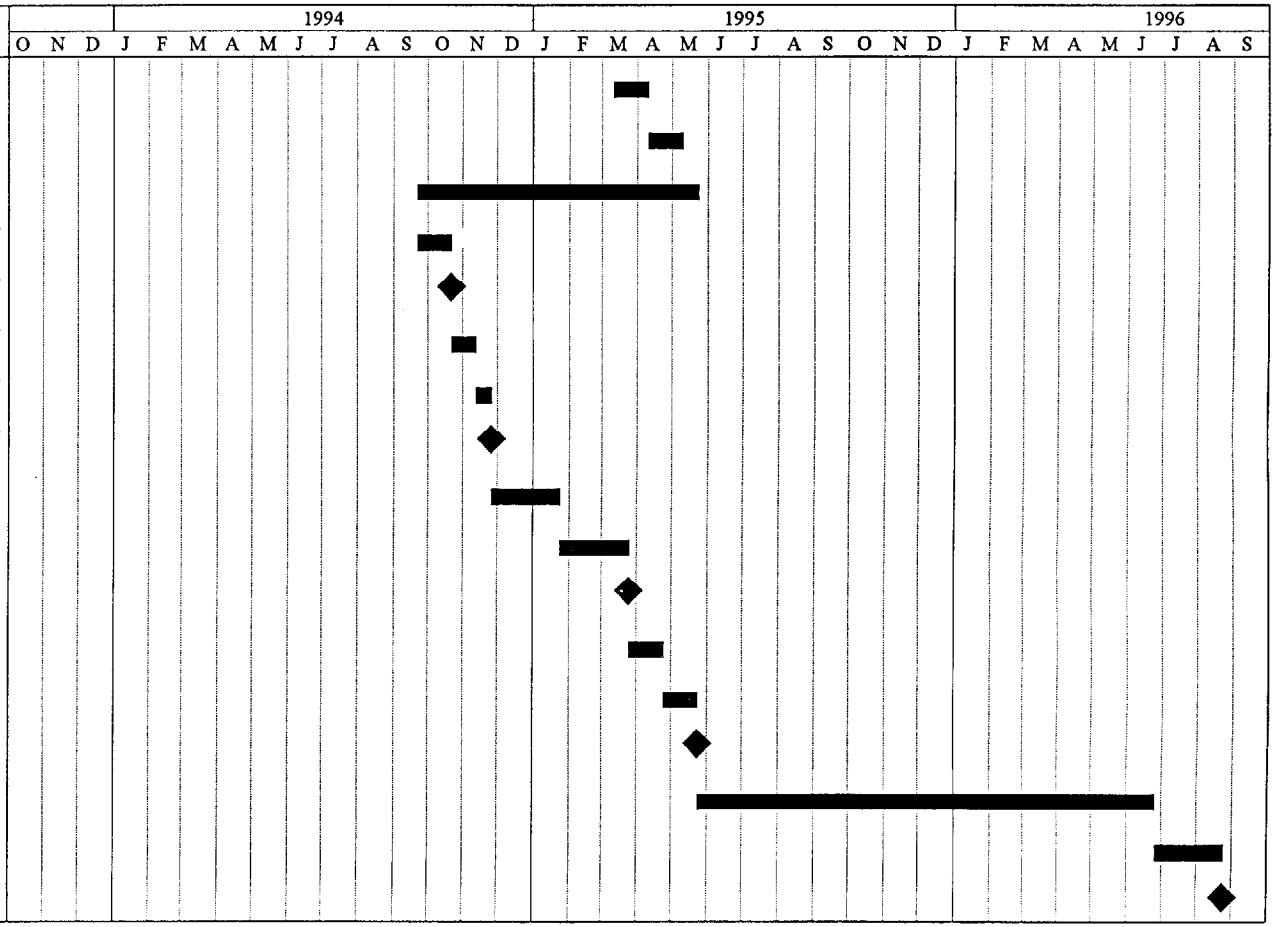


Figure 7 - 2: Expedited Site Management Schedule

Sites 41, 69 and 74 (Operable Unit No. 4), MCB Camp Lejeune, North Carolina

Task	Days	Start	Finish
Mobilization	30ed	11/19/93	12/19/93
Field Investigation	60ed	12/19/93	2/17/94
Data Analysis/Validation	116ed	12/19/93	4/14/94
Data Evaluation	42ed	4/14/94	5/26/94
RI / RA	28ed	5/26/94	6/23/94
Prepare Preliminary Draft RI	42ed	5/26/94	7/7/94
Submit Preliminary Draft RI	0ed	7/7/94	7/7/94
LANTDIV Review	28ed	7/7/94	8/4/94
Prepare Draft RI	21ed	8/4/94	8/25/94
Submit Draft RI	0ed	8/25/94	8/25/94
Agency Review	30ed	8/25/94	9/24/94
Prepare Draft Final RI	30ed	9/24/94	10/24/94
Submit Draft Final RI	0ed	10/24/94	10/24/94
Agency Review	21ed	10/24/94	11/14/94
Prepare Final RI	21ed	11/14/94	12/5/94
Submit Final RI	0ed	12/5/94	12/5/94
Prepare Preliminary Draft FS	42ed	7/4/94	8/15/94
Submit Preliminary Draft FS	0ed	8/15/94	8/15/94
LANTDIV Review	28ed	8/15/94	9/12/94
Prepare Draft FS /PRAP	21ed	9/12/94	10/3/94
Submit Draft FS/PRAP	0ed	10/3/94	10/3/94
Agency Review	30ed	10/3/94	11/2/94
Prepare Draft Final FS/PRAP	30ed	11/2/94	12/2/94
Agency Review	21ed	12/2/94	12/23/94

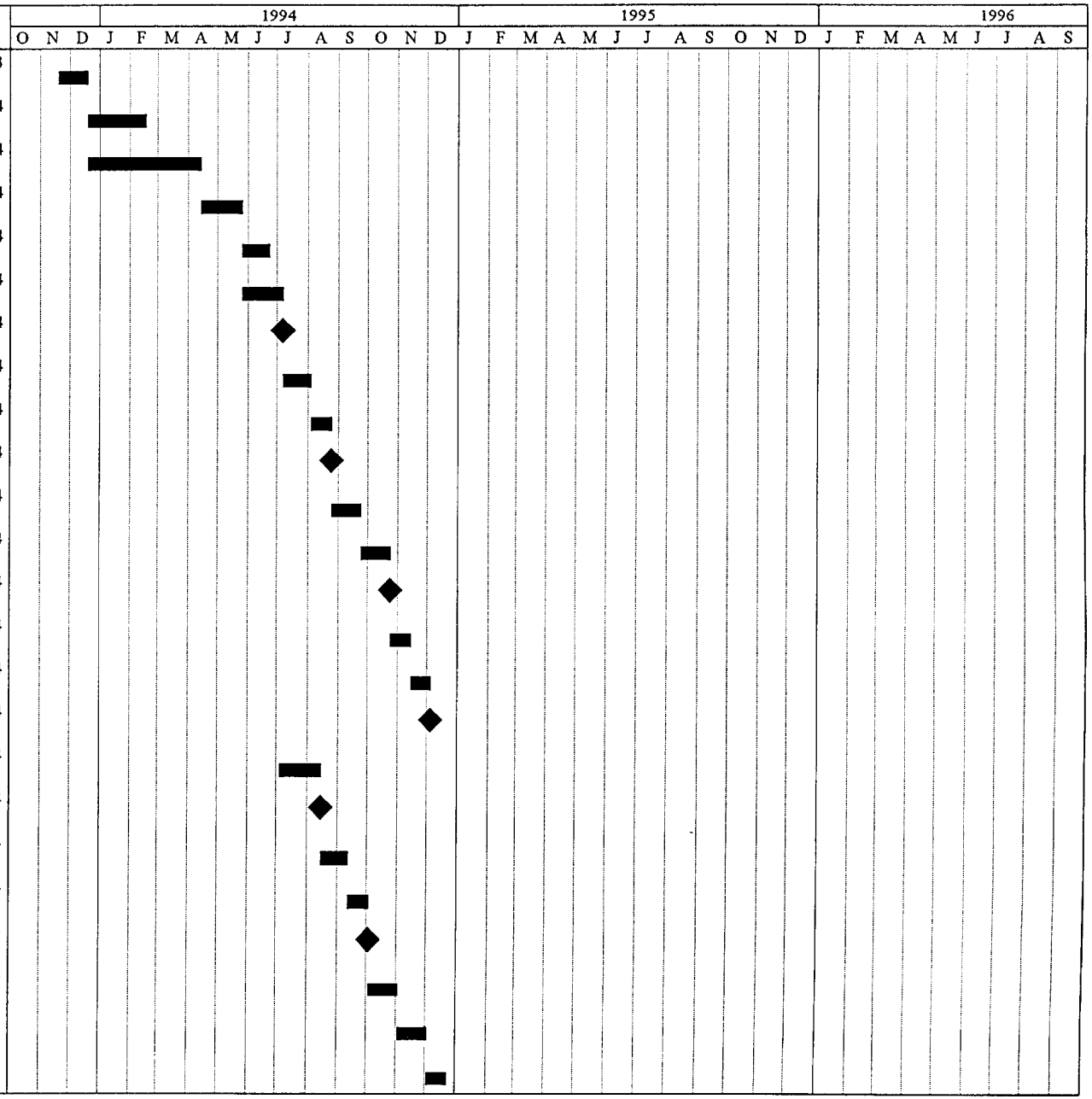
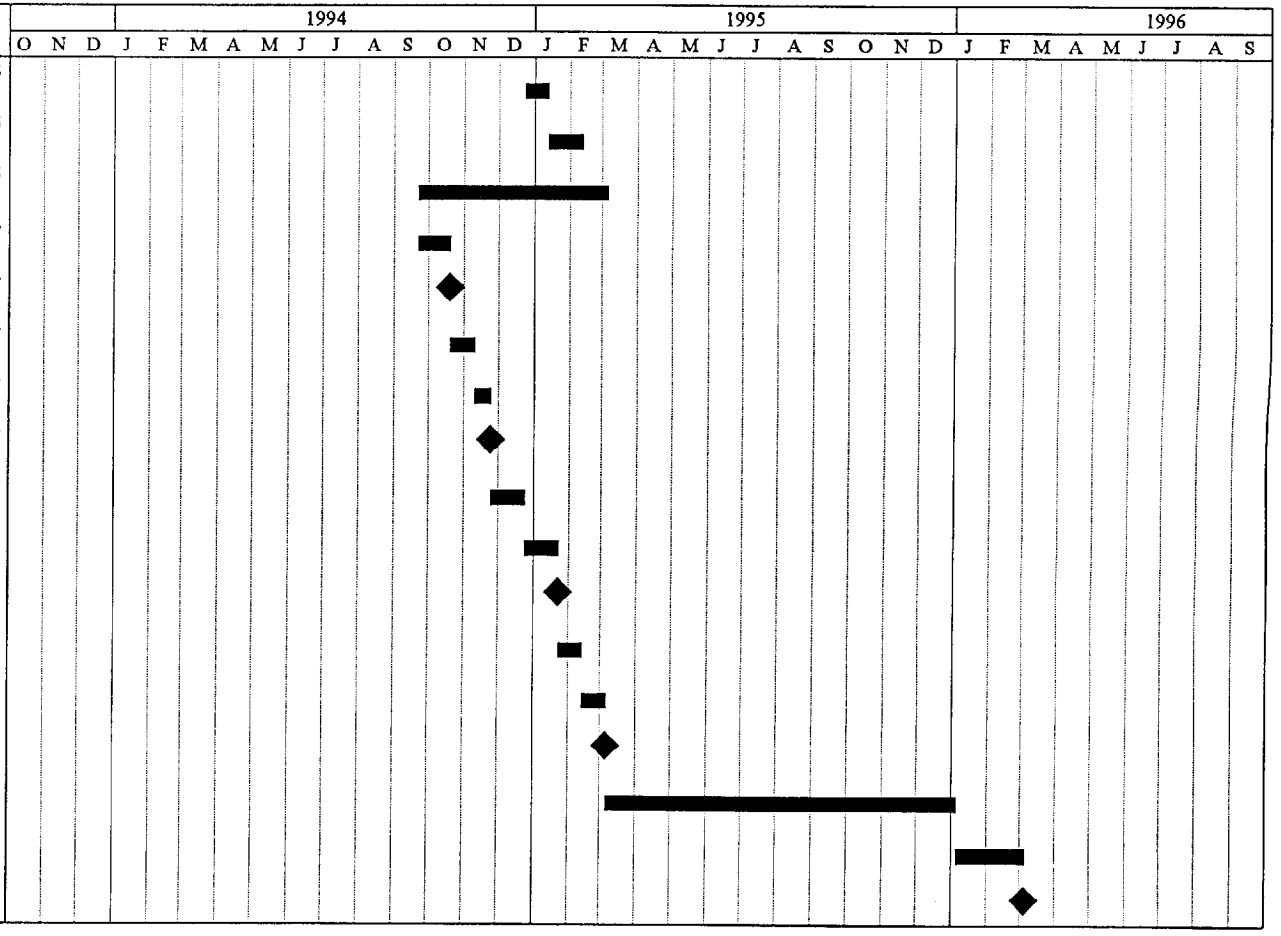


Figure 7 - 2: Expedited Site Management Schedule

Sites 41, 69 and 74 (Operable Unit No. 4), MCB Camp Lejeune, North Carolina

Task	Days	Start	Finish
Prepare Final FS/PRAP	21ed	12/23/94	1/13/95
Public Comment Period	30ed	1/13/95	2/12/95
ROD	165ed	9/22/94	3/6/95
Prepare Preliminary Draft ROD	28ed	9/22/94	10/20/94
Submit Preliminary Draft ROD	0ed	10/20/94	10/20/94
LANTDIV Review	21ed	10/20/94	11/10/94
Prepare Draft ROD	14ed	11/10/94	11/24/94
Submit Draft ROD	0ed	11/24/94	11/24/94
Agency Review	30ed	11/24/94	12/24/94
Prepare Draft Final ROD	30ed	12/24/94	1/23/95
Submit Draft Final ROD	0ed	1/23/95	1/23/95
Agency Review	21ed	1/23/95	2/13/95
Prepare Final ROD	21ed	2/13/95	3/6/95
Submit Final ROD	0ed	3/6/95	3/6/95
Remedial Design (1,2)	305ed	3/6/95	1/5/96
Procure RA Contractor (1,2)	60ed	1/5/96	3/5/96
Remedial Action (1,2)	0ed	3/5/96	3/5/96



8.0 REFERENCES

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APPENDIX A

SITE 69 AND 74 GEOPHYSICAL REPORTS

GEOPHYSICAL INVESTIGATION

SITE 74
MESS HALL GREASE PIT DISPOSAL AREA

MCB CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0106

Prepared For:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

MARCH 3, 1993

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1.0 INTRODUCTION AND PURPOSE

A geophysical survey at Marine Corps Base (MCB) Camp Lejeune, Jacksonville, North Carolina, has been conducted to locate an old disposal trench at Site 74 (Mess Hall Grease Disposal Area).

The field investigation was completed on June 18-19, 1992.

2.0 METHODS OF INVESTIGATION

To accomplish the specific project objective, the non-invasive geophysical investigation included electromagnetic terrain conductivity and ground penetrating radar techniques.

2.1 Survey Control

Geophysical data obtained during this survey were referenced by taped distance measurements to monitoring wells, roads, fences, and other physical and cultural features on site.

Survey traverses were staked and/or painted to facilitate subsequent identification by others.

2.2 Electromagnetic Terrain Conductivity

Electromagnetic (EM) terrain conductivity profiling was performed to map the lateral extent of buried waste and to identify buried metal objects and other debris on site. Instrumentation utilized for this survey included a Geonics model EM-31, with a maximum investigative depth of approximately 15 feet. EM-31 data were acquired in the vertical dipole mode at five-foot intervals along each traverse. Conductivity and in-phase measurements were performed at each station to more confidently distinguish metallic objects from non-metallic wastes or natural earth materials with high electrical conductivity.

EM-31 data were recorded using a digital datalogger and downloaded to a portable computer for profiling and interpretation.

2.3 Ground Penetrating Radar

Ground penetrating radar (GPR) profiling was conducted over the area of the suspected disposal trench in an attempt to better define the limits of excavation and to characterize the buried waste materials.

GPR profiling was completed with analog instrumentation that consisted of a GSSI SIR-7 mainframe, Adtek graphic recorder, and 500 megahertz antenna. This antenna was selected to provide high-resolution recordings of objects within a few feet of the ground surface.

3.0 RESULTS

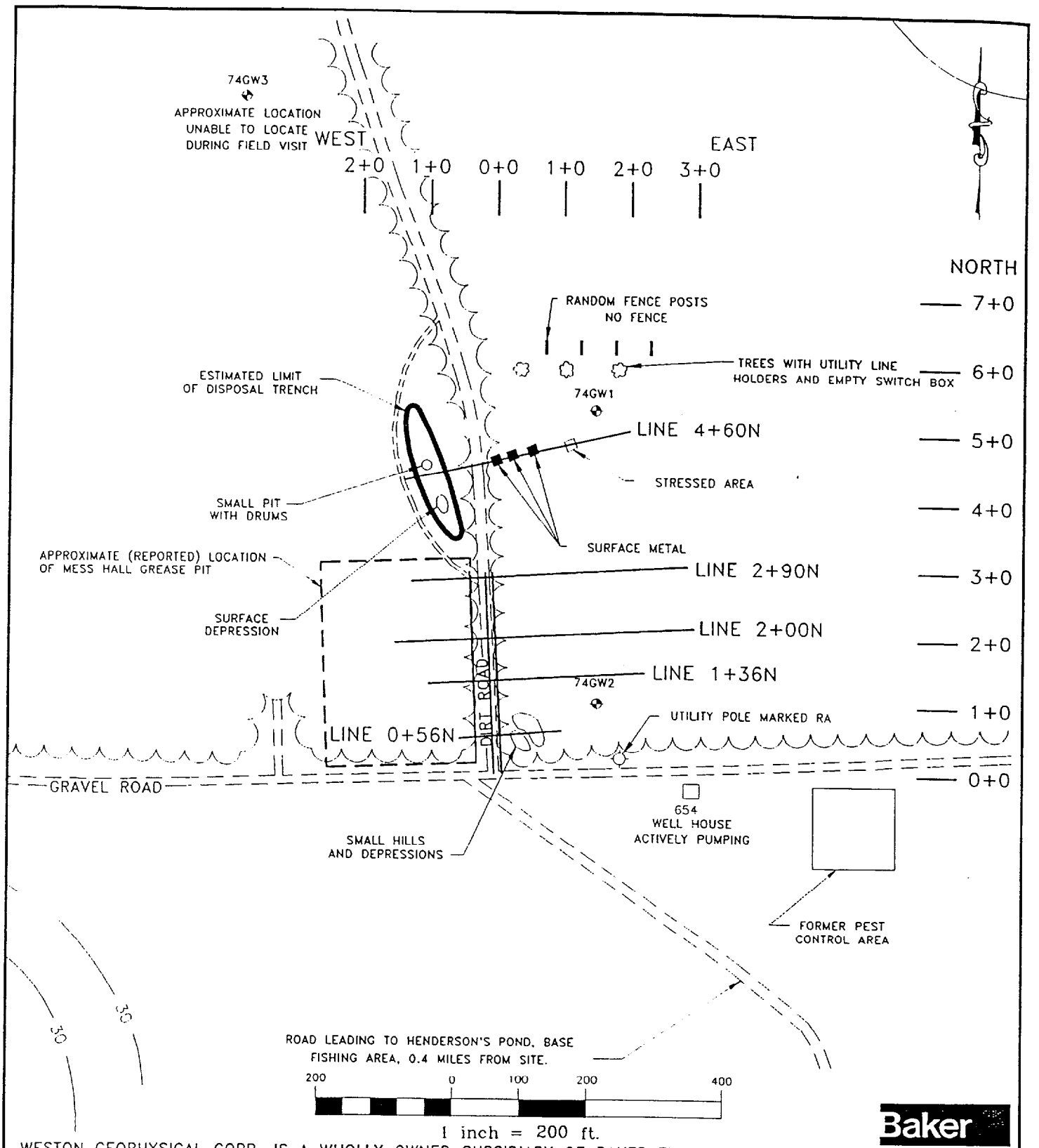
The results of the geophysical survey at Site 74 are presented in the following subsection.

3.1 Site 74 - Mess Hall Grease Disposal Area

A large trench used for the disposal of grease was reported at this site. A geophysical survey grid was established at the intersection of two roadways, where the disposal trench was reported to be. Figure A3-1 shows surface features at Site 74 and lines of geophysical coverage.

EM measurements conducted along orthogonal traverses resulted in background conductivity values between 1-3 mmhos/m. The small fluctuation of lateral conductivity values observed across this area suggest little or no subsurface disturbance, indicating that the location of the trench may have been incorrectly reported. Figure A3-2 shows the four east-west EM conductivity profiles conducted on the southern portion of the site.

A visual inspection of the area north of the entrance to Site 74, noted a small pit containing deteriorated drums. An EM traverse was conducted across this area and a large change in conductivity was measured near the pit as shown on Figure A3-2, Line 4+60N. Reconnaissance EM measurements surrounding the area allowed for an approximate delineation of the feature, which is located between two roads, as shown on Figure A3-1. This may be the grease trench or another previously unknown disposal area. (The Site Summary Report indicated that drums and pesticide-soaked bags were disposed of near the grease trench.)



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Baker Environmental, Inc.

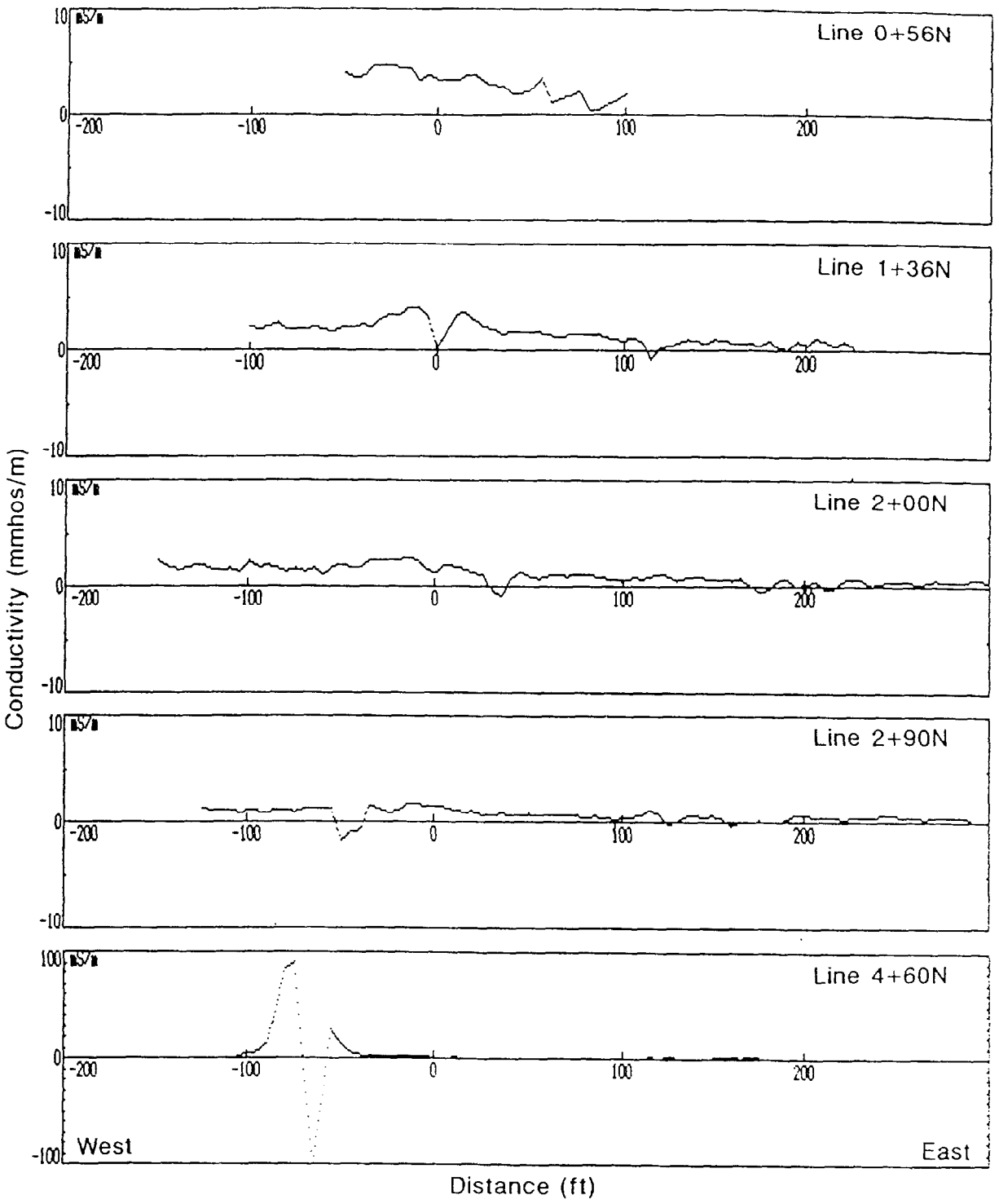
GEOPHYSICAL INVESTIGATION
MCB CAMP LEJEUNE
NORTH CAROLINA

RESULTS OF GEOPHYSICAL INVESTGATION
SITE 74 – GREASE DISPOSAL AREA

WESTON GEOPHYSICAL CORP.
Coraopolis, Pennsylvania

Date AUGUST 1992

Figure No. A3–1



Baker

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Geophysical Investigation MCB Camp Lejeune North Carolina	**EM Conductivity Profiles** **Site 74 - Grease Disposal Area**
WESTON GEOPHYSICAL CORP. Coraopolis, Pennsylvania	Date Figure No. **A3-2**

GPR was conducted across the suspected trench in an attempt to more accurately establish the limits of the trench and to further characterize any buried materials. Radar was not effective however in detecting the boundaries of the excavation nor any debris materials due to limited radar signal penetration.

4.0 CONCLUSIONS

A non-invasive geophysical survey was effective in delineating limits of disposal at Site 74. An area of waste burial was identified north of the originally reported location of the grease trench. Geophysical measurements indicated that metal objects had been included in the buried waste.

GEOPHYSICAL INVESTIGATION

SITES 6, 48, AND 69

MARINE CORPS BASE CAMP LEJEUNE
NORTH CAROLINA

CONTRACT TASK ORDER 0133

Prepared For:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared By:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

MARCH 3, 1993

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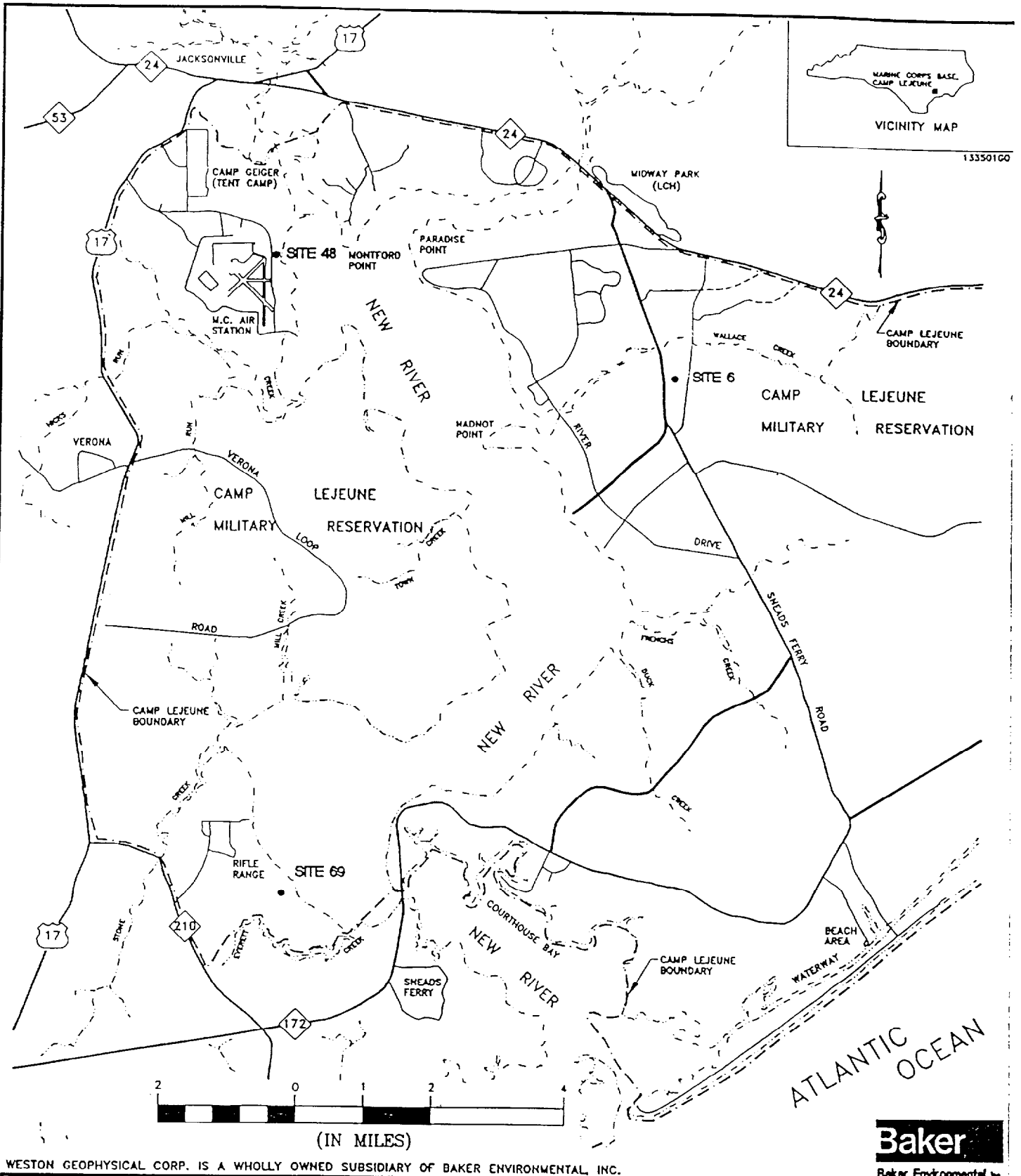
1.0 INTRODUCTION AND INVESTIGATION OBJECTIVES

A surface geophysical survey was conducted from August 24 to September 3, and December 14 to 18, 1992, at Marine Corps Base (MCB) Camp Lejeune, Jacksonville, North Carolina. The survey objectives at Site 6 - MCB Storage Lot 203 were to delineate areas of suspected disposal and to identify locations of buried metal. The survey objective at Site 48 - Marine Corps Air Station (MCAS) Mercury Dump was to detect areas of suspected mercury disposal. At Site 69 - Rifle Range Chemical Dump, the survey objectives were to delineate suspected disposal trenches and to identify areas of buried metal. Figure 1-1 shows the location of the three sites investigated.



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Baker Environmental, Inc.

GEOPHYSICAL INVESTIGATION
MCB CAMP LEJEUNE
NORTH CAROLINA

SITE LOCATION MAP
SITES 6, 48 and 69

WESTON GEOPHYSICAL CORP.
Coraopolis, Pennsylvania

DATE MARCH 1993

Fig. No. 1-1

2.0 METHODS OF INVESTIGATION

Non-invasive geophysical techniques that were utilized to meet the objectives included electromagnetic (EM) terrain conductivity, magnetometry, and ground penetrating radar (GPR).

2.1 Survey Control

Geophysical data obtained during this survey were referenced to a grid established at each site, as well as to roads, fences, wells, and other physical and cultural features on site. At Sites 6 and 48, a survey grid was established by Hoggard-Eure Associates (a licensed professional surveying company) that consisted of 100-foot and 10-foot spaced lines, respectively. Due to heavy vegetation and understory at Site 69, geophysical traverses were referenced to an old road crossing the site and located by compass bearing and taped distance measurements. These east-west oriented traverses were subsequently located and stationed at 50-foot intervals by Hoggard-Eure. A second phase geophysical investigation at Site 69 was then conducted to further define areas of suspected burial. Figures 2-1, 2-2, and 2-3 show the survey grid and surface conditions noted at Sites 6, 48, and 69, respectively.

2.2 Electromagnetic Terrain Conductivity

Electromagnetic terrain conductivity profiling was performed to map the lateral extent of buried material and to identify buried metal objects and other debris. Instrumentation utilized for this survey included a Geonics model EM-31, with an effective penetration depth of approximately 15 feet when operated in the vertical dipole mode (VDM).

The conductivity of the soil or buried materials is determined by measuring the response of the ground to an induced magnetic field. Factors affecting in-situ conductivity include porosity, moisture content, clay content, and the conductivity of subsurface fluids and materials. Former excavations or landfill boundaries may be detected through measurement of lateral variations in soil conductivity. This method may also be used to infer the presence of buried metal objects, such as drums, tanks, or utilities.

Both the quadrature-phase (terrain conductivity) and in-phase components of the EM field were measured in the vertical dipole mode. The quadrature-phase mode provides a measurement of soil conductivity, while the in-phase mode is responsive to the effects of highly

conductive, buried metallic objects. Terrain conductivity is measured in millimhos/ meter (mmhos/m) and the in-phase component is measured in parts per thousand (ppt) of the primary magnetic field.

EM-31 data were acquired at 5-foot intervals along each geophysical traverse. Both conductivity and in-phase measurements were recorded using a digital datalogger then downloaded to a portable computer for data processing and interpretation.

2.3 Magnetometry

Magnetic profiling was performed to complement the EM interpretation of subsurface objects and debris. A digital proton precession magnetometer (Geometrics model G-856X) was utilized for this geophysical investigation. Perturbations to the ambient magnetic field are indicative of nearby ferrous metal. The magnitude of these perturbations are a function of the mass of the metal object. The magnetometer measures the magnitude of the magnetic field to a resolution of 1.0 gamma.

Magnetic data were acquired at 10-foot stations along selected traverses, and a magnetic base station was reoccupied at approximately one hour intervals to facilitate adjustment of the data for natural daily variations due to solar activity.

The magnetic data were downloaded to a portable computer, corrected for diurnal drift, and profiled prior to interpretation. The magnetic data were then compared to EM conductivity and in-phase data to determine whether specific geophysical anomalies were caused by ferrous or non-ferrous buried objects or fill.

2.4 Ground Penetrating Radar

Ground penetrating radar is an electromagnetic survey technique that reveals a graphic cross-sectional view of subsurface stratigraphy and buried objects (i.e., drums, pipelines, tanks, boulders, etc.). Data acquisition is continuous along lines of coverage and a graphic recorder provides an immediate view of the data, yielding both horizontal (lateral) and vertical (depth) control information. Penetration (typically 2-8 feet) and resolution are determined by the frequency of the antenna, but the overall effectiveness of GPR can be limited by highly reflective materials such as water-saturated clay, salt, slag, or highly conductive inorganic materials.

GPR profiling was completed with analog instrumentation that consisted of a GSSI SIR-7 mainframe, Adtek graphic recorder, and 500 megahertz antenna. This antenna was selected to provide high-resolution recordings of buried objects within the landfill.

GPR profiling was conducted in an attempt to provide further characterization of subsurface conditions and buried materials, e.g., to distinguish buried drums from concrete debris with steel rebar and to more precisely delineate the limits of any excavation. GPR profiles were obtained along selected traverses at Sites 6, 48, and 69.

3.0 RESULTS

The geophysical survey at Sites 6, 48, and 69 are presented in the following subsections.

3.1 Site 6 - Storage Lot 203

Site 6 is located approximately two miles east of the New River, on the Mainside portion of MCB Camp Lejeune. Lot 203 is located within Site 6. It covers approximately 225 acres on the northern end of Site 6 and is composed of both open and wooded areas. Historical photographs of Lot 203 depict numerous trenches that were excavated and backfilled. Solid wastes were likely disposed of in these trenches. Lot 203 was reportedly used as a waste storage area. The area of investigation and lines of geophysical coverage are shown on Figures 2-1.

A geophysical survey grid was established on site and referenced to 100-foot spaced parallel traverses which had been located and staked by Hoggard-Eure Associates. EM conductivity measurements showed background conductivity levels in the range of 5-10 mmhos/m. Distinct increases in conductivity above 100 mmhos/m, representative of a significant lateral change in conductivity due to buried waste and fill material, was measured along both north/south and east/west oriented lines across three broad areas in the western portion of the site as shown on Figure 2-1. Other more localized areas of anomalously high conductivity are also shown.

A widespread area containing buried metal was detected in the southern portion of the site, inside the perimeter fence and approximately parallel to the southern perimeter road as shown on Figure 2-1.

Buried metal was also detected in the wooded area on the eastern portion of the site as shown on Figure 2-1. Additional geophysical lines of coverage were added in order to better define potential areas of disposal within the woods. One area is centered near grid coordinates 15+00E/6+00N and its shape is characteristic of a trench.

Magnetic measurements were generally erratic across the entire site and due in part to the presence of surface metal objects and scattered scrap metal and debris. Areas of buried metal delineated on Figure 2-1 were coincident with anomalously high magnetic intensities, indicating the presence of buried ferrous metallic objects.

Several geophysical lines were extended to the north beyond the perimeter fence. As shown on Figure 2-1, conductivity measurements indicate that fill materials or buried debris may extend beyond the perimeter fence in the northeast corner of the lot.

3.2 Site 48 - MCAS Mercury Dump

Site 48 is located east of MCAS on the west bank of the New River. The site is grass covered east of Longstaff Road to the tree line and heavy vegetation located along the river bank. It has been reported that metallic mercury was periodically disposed in the area extending from the rear of Building AS804 to the New River. A geophysical survey grid was established in this area by Hoggard-Eure Associates, extending from Buildings AS804 and AS805 northeast towards the New River. The area of investigation and specific lines of geophysical coverage are shown in Figure 2-2.

EM measurements showed background conductivity levels ranging between 10-20 mmhos/m across the site. This is within the limits of natural conductivities that would be expected for saturated silty soil underling this area adjacent to the New River. No lateral changes in conductivity were encountered which might indicate areas of previous disposal and backfill. However, in-phase measurements indicated the presence of a highly conductive, buried metallic material north of Building AS804, along Lines 0+40E and 0+50E near station 2+00N, as indicated on Figure 2-2. This appears to be unrelated to the numerous buried utilities on site which were detected by GPR conducted along several survey lines.

3.3 Site 69 - MCB Rifle Range Chemical Dump

Site 69 is located west of the New River estuary, within MCB Camp Lejeune. The site is approximately 10-12 acres and is heavily wooded. The site was used as a chemical waste dump and materials were reportedly disposed in pits and trenches. These materials may include chemical surety materials (CSM), such as blister or nerve agents. The area of investigation and lines of geophysical coverage are shown in Figure 2-3.

EM conductivity and magnetic intensity measurements were obtained along orthogonal traverses extending across the site. EM measurements showed background conductivity levels at 10 mmhos/m. A distinct increase in conductivity above 10 mmhos/m, representative of a lateral change in conductivity due to buried waste and fill material, was measured across

two broad areas as shown on Figure 2-3. Within these two areas, EM in-phase and magnetic measurements indicated buried metallic and ferrous metallic objects.

The greater lateral extent of increased conductivity, to that of detected buried metal, may suggest that previous widespread burial of non-metallic debris on site may have occurred. Furthermore, zones of highest conductivity were not always coincident with the area of buried metal, suggesting widespread disposal on-site. An alternative explanation for the lateral extent of increased conductivity, primarily to the south and north, may be the presence of a conductive contaminant plume.

4.0 SUMMARY AND CONCLUSIONS

Conclusions of the geophysical investigations conducted at Sites 6, 48, and 69 are presented below.

4.1 Site 6 - Storage Lot 203

At Site 6, the geophysical survey indicated widespread burial of debris and materials primarily on the west and south portions of Lot 203. Scattered, buried metallic and ferrous metallic objects were detected at numerous locations across the site, including the wooded areas on the east and north sides of Lot 203.

An area measuring approximately 100 x 600 feet along the southern perimeter fence was identified as an area of widespread buried metal. This area is coincident with several burial trenches identified in the interim Environmental Photographic Interpretation Center (EPIC) report on 1952-1970 aerial photographs.

Locations of buried metal were identified in the wooded portion of the site. One location measures approximately 50 x 200 feet and is not coincident with any burial trench identified on aerial photographs by EPIC.

Based on the geophysical survey, the disposal of materials appears to extended approximately 100-200 feet beyond the perimeter fence at the northeast corner of Lot 203.

4.2 Site 48 - MCAS Mercury Dump

At Site 48, EM terrain conductivity measurements exhibited no lateral changes in conductivity or elevated levels of conductivity above background, which could be indicative of mercury disposal areas. However, in-phase measurements indicated the presence of a highly conductive, buried metallic material approximately 50-60 feet north of Building AS804. This area appears to be unrelated to numerous buried utilities on site detected by GPR and is partially coincident with a suspected disposal area identified on 1960 and 1964 aerial photographs by EPIC.

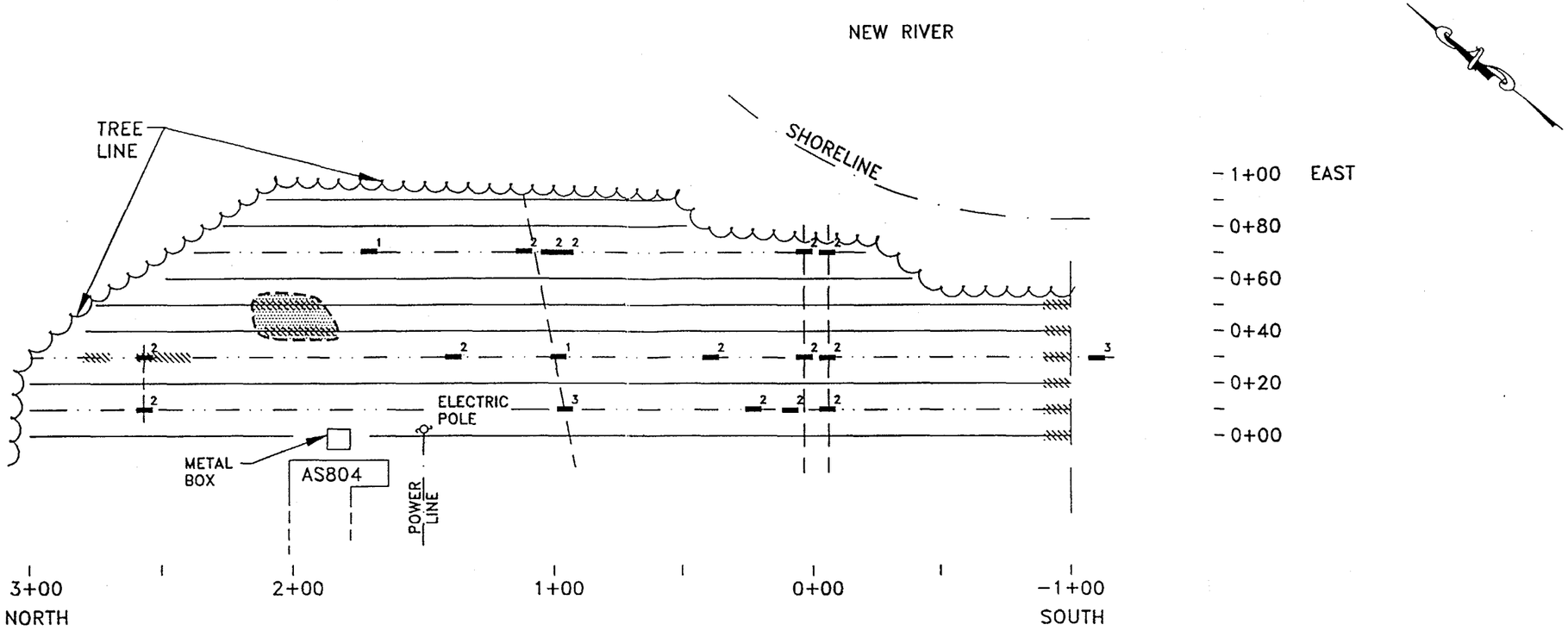
4.3 Site 69 - Rifle Range Chemical Dump

At Site 69, lateral changes in conductivity were observed across two broad areas located in the south and north portions of the site. In the central portion of the site and partially coincident with the increased conductivities, buried metallic and ferrous metallic objects were detected. The greater lateral extent of increased conductivity relative to that of the buried metal locations, may indicate the previous widespread burial of non-metallic materials and/or the limits of a conductive contaminant plume. The areas identified with geophysics appear to be coincident with burial trenches identified on 1956, 1958, and 1964 aerial photographs by EPIC.

REVISIONS			
WESTON GEOPHYSICAL CORP. IS A WHOLLY OWNED SUBSIDIARY OF BAKER ENVIRONMENTAL, INC.	DATE MARCH 1993 SCALE 1"= 200' DRAWN REL REVIEWED MJN S.O.# 19133-54-SRN CADD# 133510GO	GEOPHYSICAL INVESTIGATION MCB CAMP LEJEUNE NORTH CAROLINA WESTON GEOPHYSICAL CORP. Coraopolis, Pennsylvania	Baker Baker Environmental, Inc.

SITE 6 - LOT 203 EM SURVEY RESULTS	FIGURE NO.
SCALE 1"= 200' DATE MARCH 1993	2-1

023173092



LONGSTAFF ROAD

50 0 25 50 100

1 inch = 50 ft.

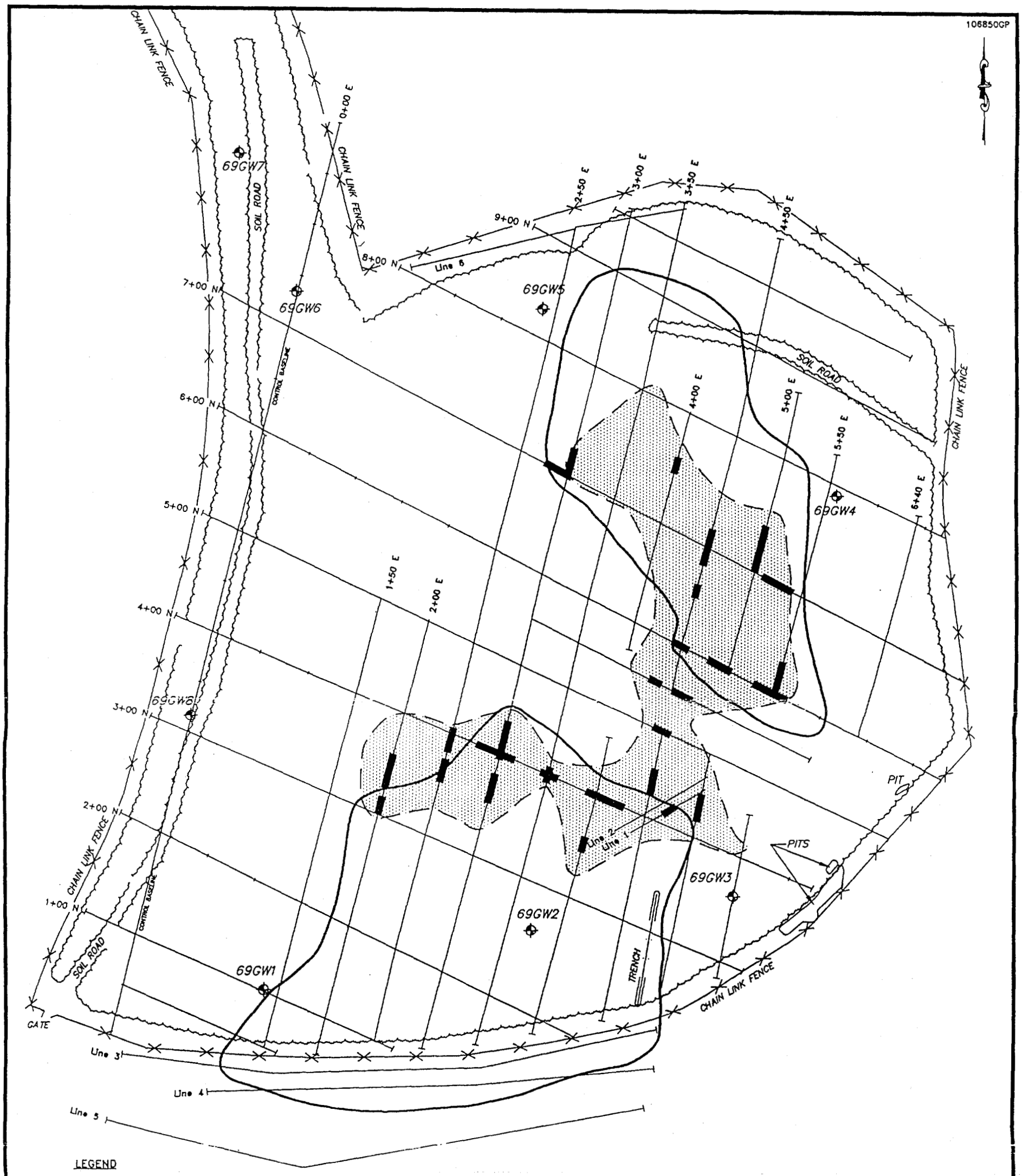
LEGEND

- EM AND GPR SURVEY LINE
- EM SURVEY LINE
- BURIED OBJECT/UTILITY
- CONDUCTIVITY REVERSAL INDICATIVE OF BURIED METAL
- INFERRED UTILITY TREND
- INTERPRETED AREA OF BURIED METALLIC MATERIAL

REVISIONS				
WESTON GEOPHYSICAL CORP. IS A WHOLLY OWNED SUBSIDIARY OF BAKER ENVIRONMENTAL, INC.	DATE MARCH 1993 SCALE 1"= 200' DRAWN REL REVIEWED MJN S.O.# 19133-54-SRN CADD# 133503GO	GEOPHYSICAL INVESTIGATION MCB CAMP LEJEUNE NORTH CAROLINA	Baker Baker Environmental, Inc.	SITE 48 EM SURVEY RESULTS SCALE 1"= 200' DATE MARCH 1993	FIGURE NO. 2-2

WESTON GEOPHYSICAL CORP.
Coraopolis, Pennsylvania

02317S10Z



WESTON GEOPHYSICAL CORP. IS A WHOLLY OWNED SUBSIDIARY OF BAKER ENVIRONMENTAL, INC.

Baker Environmental, Inc.

GEOPHYSICAL INVESTIGATION MCB CAMP LEJEUNE NORTH CAROLINA	SITE 69 EM AND MAG SURVEY RESULTS
WESTON GEOPHYSICAL CORP. Coraopolis, Pennsylvania	DATE MARCH 1993 / Fig. No. 2-3

023175112

APPENDIX B

SITE 69 AND 74 EPIC REPORTS

Study Area 69 (Rifle Range Chemical Dump)

Study Area 69 consists of a former rifle range which has been designated by collateral information as a disposal point for hazardous chemicals. According to the available collateral information, a landfill was active within Study Area 69 within a time frame from the early 1950's to sometime around 1976. It is known that pesticides, polychlorinated biphenyls (PCBs), pentachlorophenol, trichloroethylene (TCE) and many other compounds were buried here. Tests indicate that surface water, the rifle range wells, and down-gradient tributaries to the New River (including Everett Creek) contained elevated levels of organic contaminants and volatile organic compounds.

The photography reveals that Study Area 69 initially consisted of a rectangular area of cleared/disturbed ground situated within a densely forested area. This area of disturbed ground consequently underwent continued revegetation from 1958 to 1980. Three trench-shaped excavations which contained liquid and/or material were present within this site from 1949 to 1964. Sometime between 1964 and 1970 these trenches were filled. The areas above and around the locations of the filled trenches were graded in 1970. With the exception of a small cleared area in 1974 which was revegetated in 1975, no further significant activity was observed. Study Area 69 was inactive in 1980.

It should be noted that at no time did the appearance of Study Area 69 conform to the signature of a typical "rifle range." The presence of the irregularly spaced trenches and the liquid they frequently contained suggests that Study Area 69 was used for a different purpose. The fact that the trenches were filled and graded over between 1964 and 1970 also substantiates this conclusion.

OCTOBER 22, 1949

No significant activity was noted during this year of analysis. The road/trail leading from south to north past the future location of the rifle range/landfill is visible. Due to the lack of significant activity, this year of photography was not reproduced for this report.

FEBRUARY 1, 1956 (FIGURE 30)

Drainage has been annotated on this year of photography. Changes that occur to drainage will be annotated on successive years of photography.

Activity is first noted at this site in this year of photography. The site consists of a partially revegetated, disturbed ground area which, according to collateral information, was used at some point as a rifle range. Two trenches are visible along the southeastern borders of the disturbed ground area. TR1 contains dark-toned liquid. Note that any potential overflow of liquid from TR1 would flow south into the drainage pathway which eventually leads east into Stones Bay (not shown).

Two sections of TR2 have been excavated. A dark-toned area of material (possibly vegetation) is visible adjacent to TR2. Several mounds of light-toned material (presumably excavated from the trenches) are present next to TR1 and TR2. A small linear mound of material is also visible along the north edge of the rifle range.

NOVEMBER 23, 1958

Photography from 1958 was not reproduced for this report. Any significant features from the 1958 year of photography will be annotated on the figure for 1964.

In 1958, a small drainage channel was visible for the first time, leading away from the southeast corner of Study Area 69. By 1958, TR1 and TR2 have become enlarged. TR3 is now visible and appears to be connected to the south edge of TR2. Note that an approximate southern half of the range (between the trenches

and the road/trail) has been cleared. The northern half of the disturbed ground area visible in 1956 continues to revegetate.

FEBRUARY 10, 1964 (FIGURE 31)

The northern half of Study Area 69 continues to revegetate. TR1-3 remain visible. TR1 contains probable medium-toned liquid. The vehicle pathway and associated cleared area visible in 1958 have revegetated. TR2 and TR3 are revegetating (not annotated). A small cleared area is visible within the wooded areas south of Study Area 69. Farther south, an even larger area, which appears to be in the process of being cleared, is visible.

OCTOBER 4, 1970 (FIGURE 32)

TR1-3 have been filled. Most of the former rifle range has revegetated, except for a graded area visible at the location of the disturbed ground area seen in 1958 and two additional graded areas noted at the former locations of TR2 and TR3. A solitary pool of probable liquid is seen within the northern graded area.

Note also that the cleared areas visible south of Study Area 69 in 1964 have since revegetated.

1974

An additional cleared area was visible on 1974 photography which was available for analysis but not available for publication.

1975

No significant change was observed on 1975 photography which was available for analysis but not available for publication.

NOVEMBER 7, 1980

By 1980 all of the cleared areas seen in 1974 have revegetated. No significant activity was noted; therefore, photography from 1980 was not reproduced for this report.

Study Area 74 (Mess Hall Grease Pit)

Photographic enlargements and text for Study Area 74 are not included in this interim report.

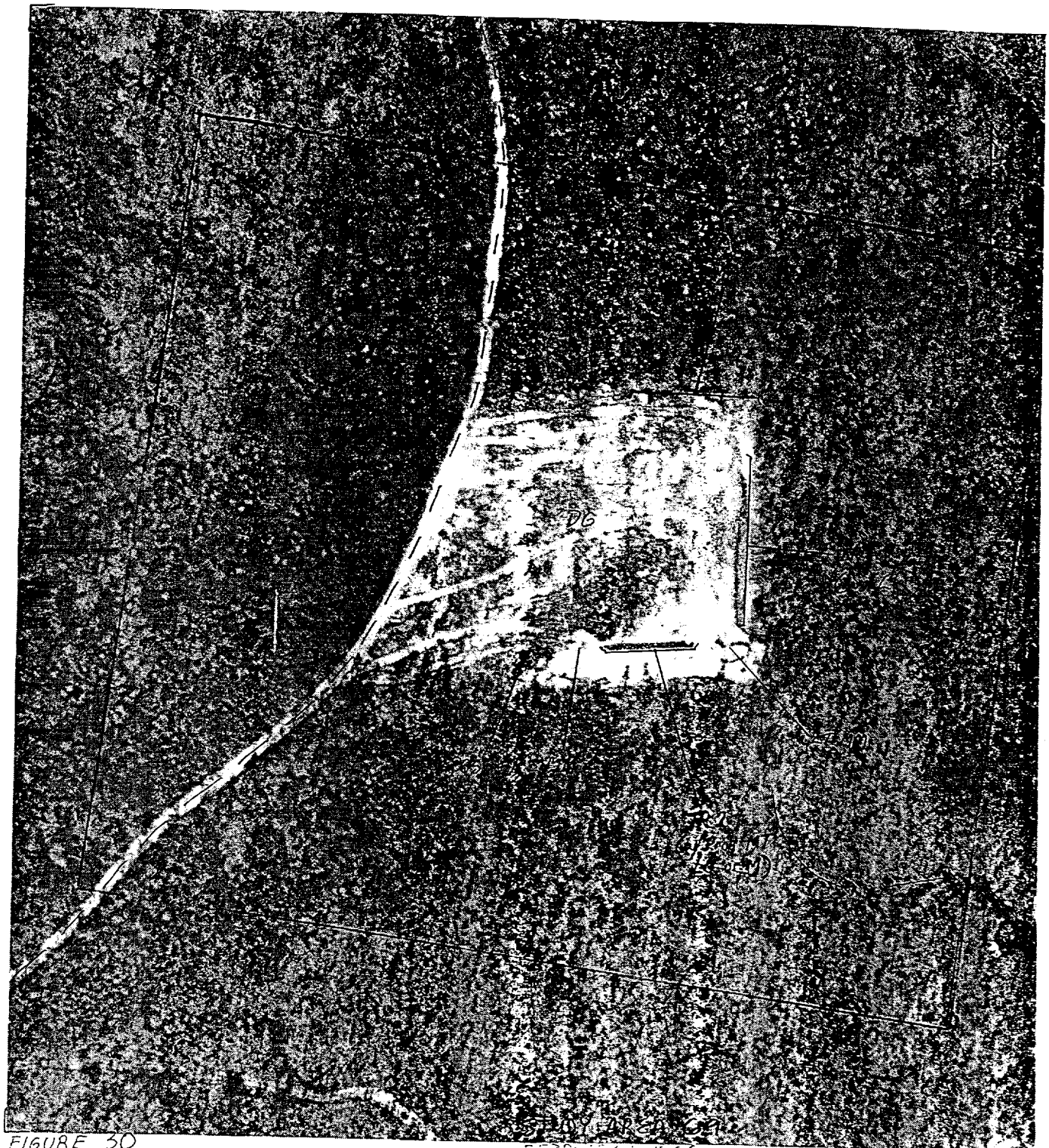


FIGURE 30
CAMP LEJEUNE

APPROX. SCA.

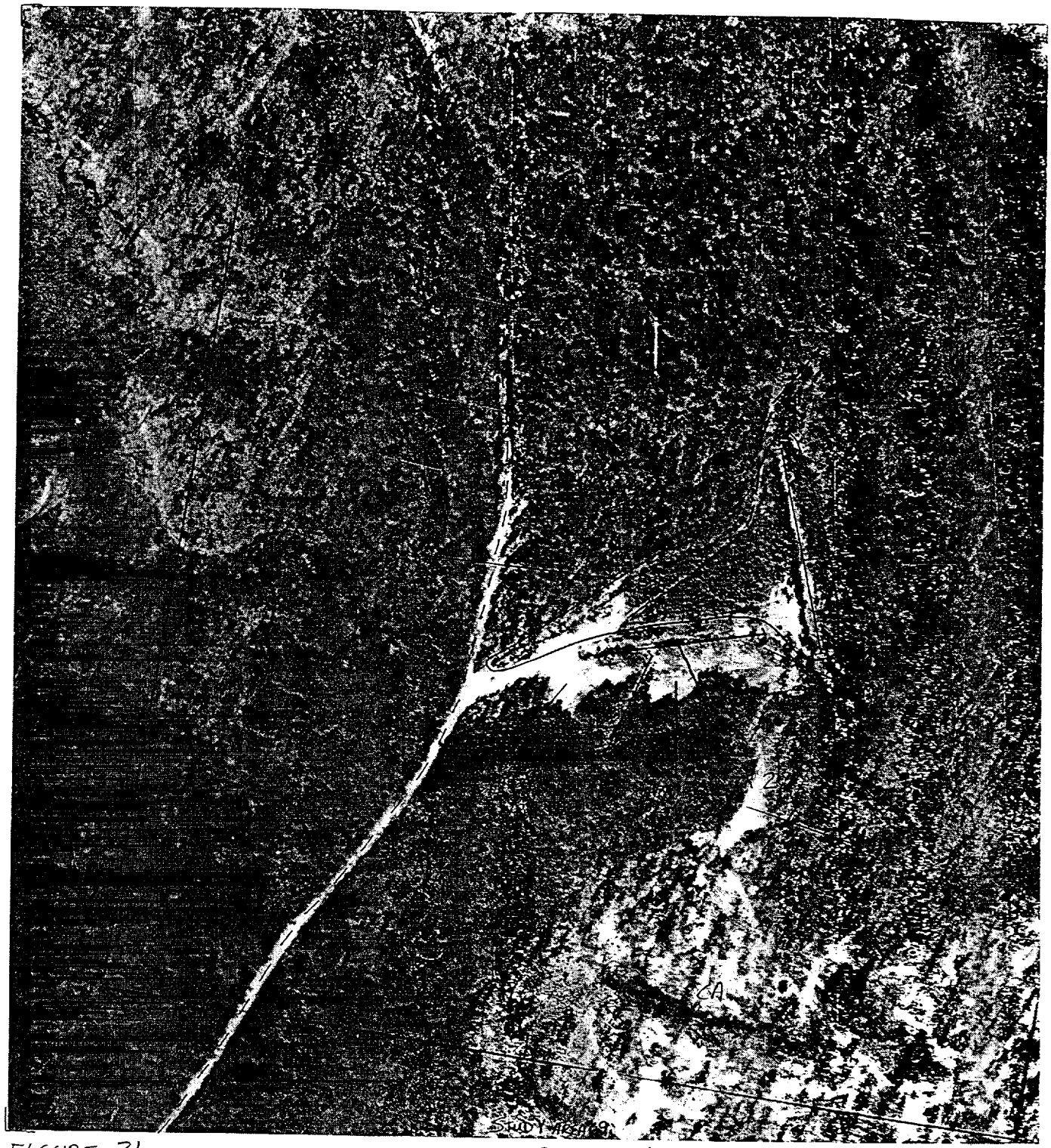


FIGURE 31
CAMP LEJEUNE

FEBRUARY 10, 1964

APPROX. SCALE 1:

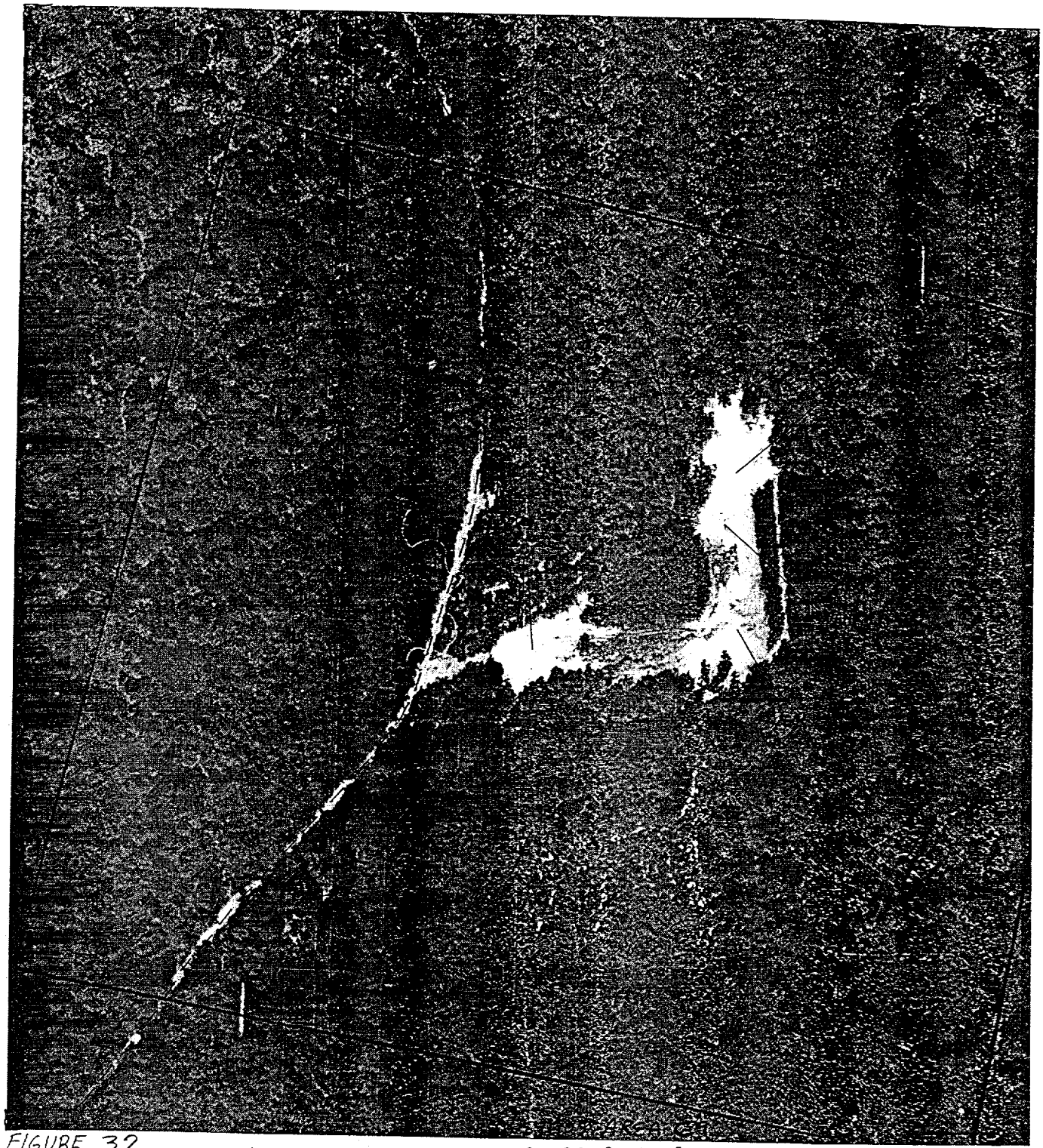


FIGURE 32
CAMP LEJEUNE

OCTOBER 4, 1970

APPRO

Camp LeJeune Study Area 74
Mess Hall Grease Disposal Area

Photography covering Study Area 74 was analyzed to document historical activity. Study Area 74, the mess hall grease disposal area, is composed of two main areas; the grease disposal area and the pest control area. Their exact locations and dates of activity are unknown. Reportedly, the size of the disposal area was approximately three acres (1.7 hectares) and it contained a grease pit measuring 135 feet long, 30 feet wide, and 12 feet deep. The pest control area was estimated at 100 feet square. Reportedly, the study area was used from the early 1950s until 1960, but the grease pit was unused after 1954.

Analysis of available aerial photography identified activity indicating the location of the grease disposal area. Additional significant activity located in the southern portion of the study area may identify the location of the pest disposal area, or some other significant historical activity.

April 24, 1938

The study area does not exist in 1938. The area comprising the study area is a mixture of pasture and woodland. Extraction activity is located in several locations in and around the study area.

November 8, 1944

Extraction activity has apparently ceased.

October 21, 1949 (Figure 33)

Extraction (EXT) areas visible in previous years are revegetating (REV), although scattered areas of ground scarring (GS) remain. One building(B) is located on the south side of an east-west oriented dirt road bisecting the study area.

One surface drainage feature is just east of the study area and flows to the southeast.

February 10, 1952 (Figure 34)

A probable bulldozer, dump truck and grader are located at a linear graded area (GR) in the west portion of the study area. No disposal activity is discernible at this location. However, farther east, a dirt road extends north from the east-west access road to a light-toned (LT) circular ground scar at an isolated location within the woods.

Extensive piles of multi-toned mounded material (MM) were disposed at the southern portion of the study area since 1949. This material covers most of southern portion of the study area and may indicate the location of the pest disposal area. The ground surface appears very rough and irregular.

February 1, 1956 (Figure 35)

The actively used portion of the study area was greatly enlarged to the north since 1952. Two trenches (TR1, T2) are excavated at the site. Trench 1 is visible as a linear northwest-southeast oriented dark tone. This tone may be caused by shadow.

Trench 2 is also oriented northwest-southeast and filled with liquid. A probable trench is located in the northern portion of the site. An oval shaped pool of liquid, possibly a trench, is located parallel to TR2. Light-toned mounded material (MM) located near the trenches is probably overburden. Several dark-toned areas, not annotated, visible between T1 and T2, may be patches of vegetation. One pit containing medium-toned liquid (LQ) is located in the northern portion of the site. Several pools of liquid are present but may represent accumulated surface drainage rather than disposal. No equipment is visible this year.

South of the access road, the probable mounded material is revegetating, with the amount of material approximately the same as in 1952.

The isolated light-toned circular ground scar noted in 1952 remains but appears unchanged and will no longer be annotated or discussed.

November 29, 1960 (Figure 36)

Trenches TR1 and TR2 remain. TR1 is partially obscured by shadow but appears empty. TR2 remains filled with liquid. The probable trench remains and appears empty. The oval shaped pool of liquid, that is possibly a trench remains visible. The pit containing liquid in 1956 remains. The pit appears shallow and mostly filled. The ground surface in this portion of the study area is mostly graded. No refuse or debris is discernible.

South of the east-west access road, a new building was added and is the likely reason for adjacent ground scarring. A small structure (S) was built southwest of this new building. Other than the new building and structure, this portion of the study area continues to revegetate. Buildings and structures in this portion of the study area will continue to be annotated but no longer discussed.

February 10, 1964 (Figure 37)

Two possible pits containing liquid are visible at the north end of the study area. The western of these two possible pits approximates the location of a pit visible in 1956 and 1960. Trenches TR1 and TR2 and the probable and possible trenches may remain but are located within an extensive area of liquid covering the ground surface. It could not be determined if these large areas of liquid were just accumulated surface runoff or if they represented some type of disposal activity. Extensive areas of liquid are also located south of TR1 and TR2.

October 4, 1970 (Figure 38)

Two areas of wet ground occur where two possible pits containing liquid were located in 1964. The portion of the study area where TR1, TR2, and a probable trench were previously visible is revegetating. TR2's former location is now clearly discernible; trees mark its location and contrast against the adjacent grassy areas within the site. A small amount of liquid remains where the possible trench was previously identified. Pools of liquid are present on the ground surface but do not appear related to disposal

activity.

One building and one structure were removed at the southern portion of the study area (BR), (SR).

LEGEND

B -Building
BR -Building Removed
DA -Disposal Area
EXT-Extraction Area
GR -Grading
GS -Ground Scarring
LQ -Liquid
LT -Light-toned
MM -Mounded Material
S -Structure
SR -Structure Removed
TR -Trench
WG -Wet Ground

——— -Access Road
——— -Feature Boundary
—·— -Natural Drainage
▬▬▬ -Study Area Boundary

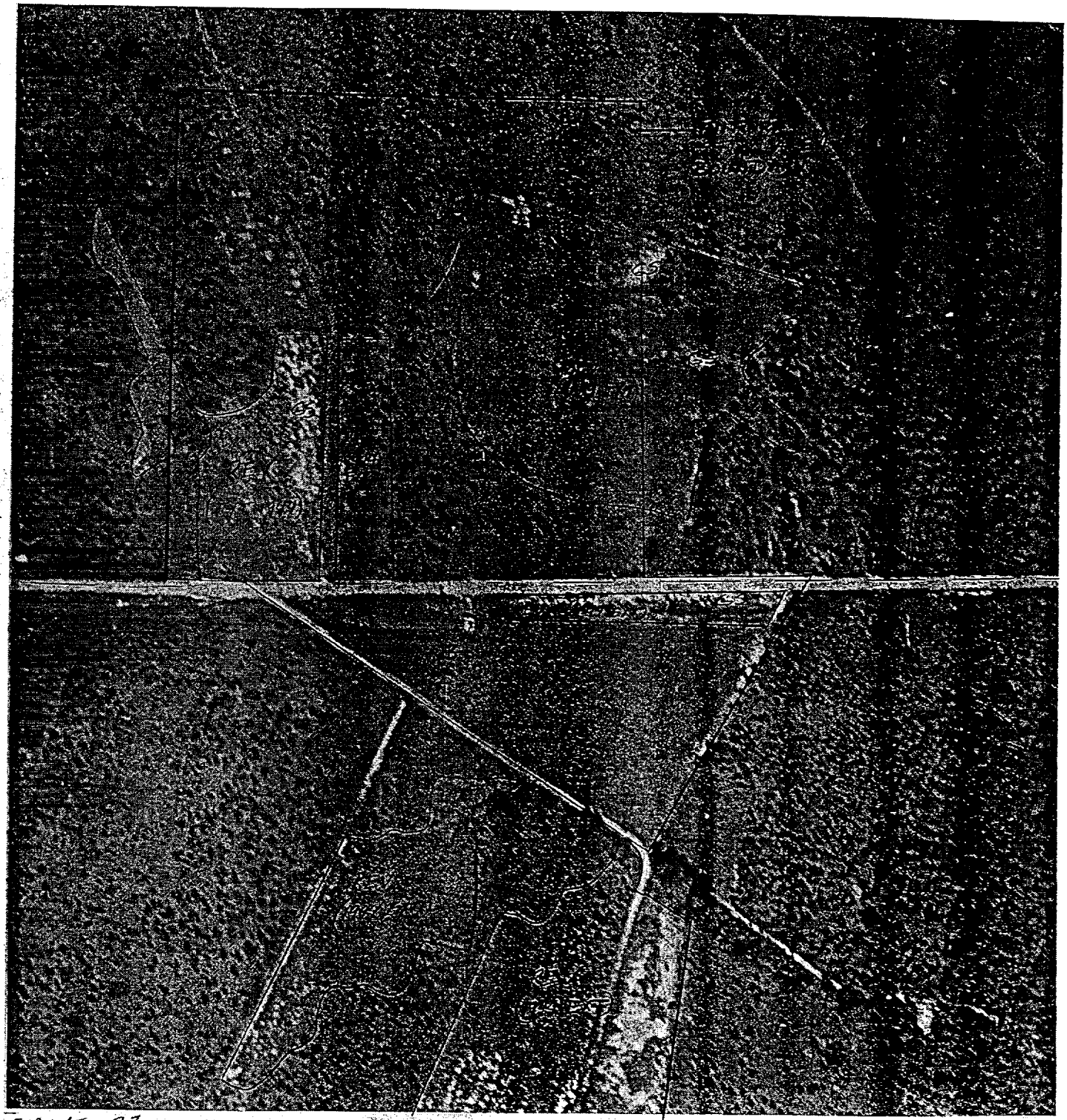


FIGURE 33
CAMP LEJEUNE STUDY AREA 14 OCTOBER 21, 1949 APPROX SCALE 1: 2,000

FIGURE 34
CRAWLEYVILLE STUDY AREA 7C1

FEBRUARY 10, 1982

APPROX SCALE 1:2,

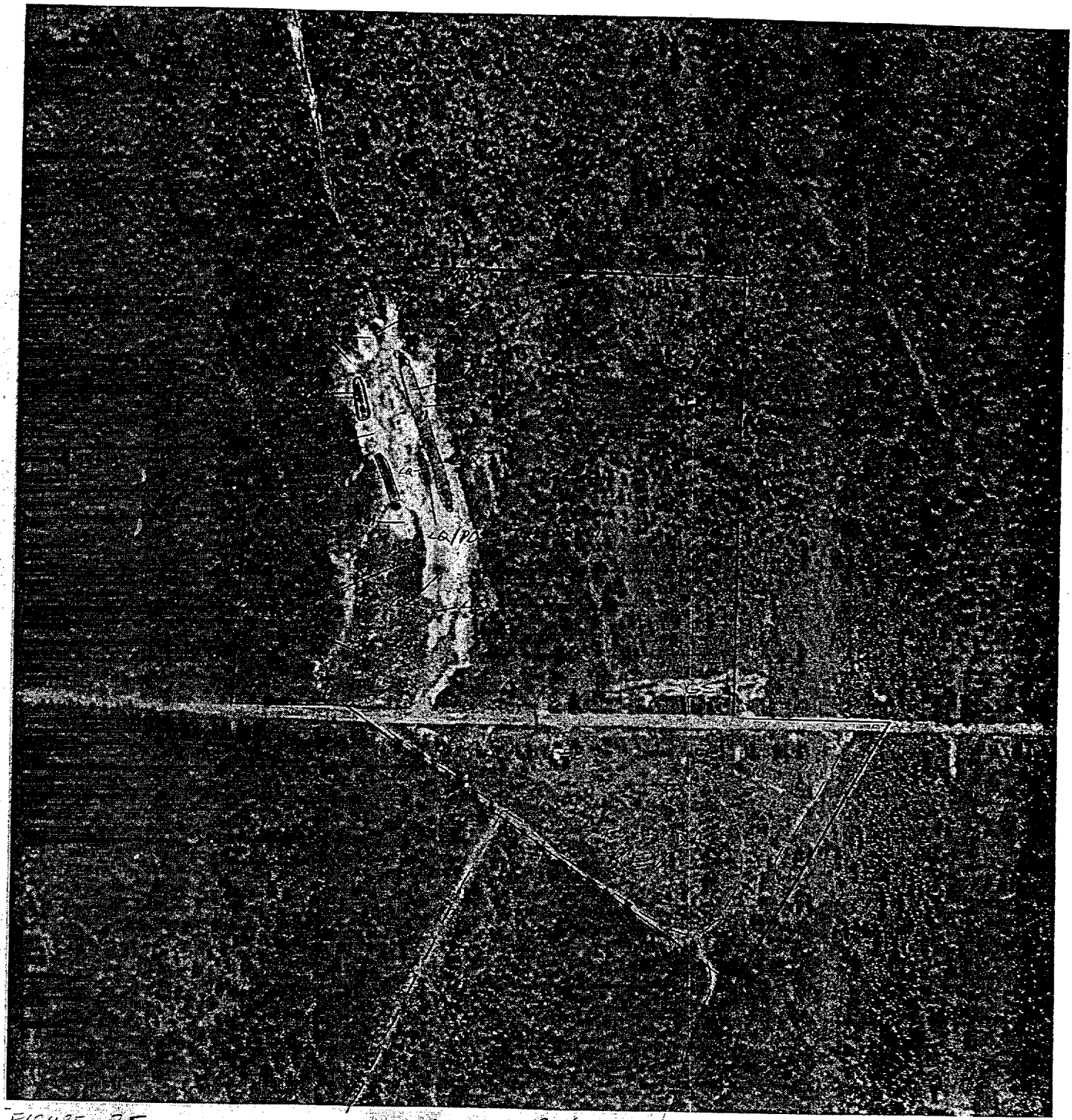


FIGURE 35 FEBRUARY 1, 1956 APPROX. SCALE 1" = 2000'

CAMP LEJEUNE STUDY AREA 74

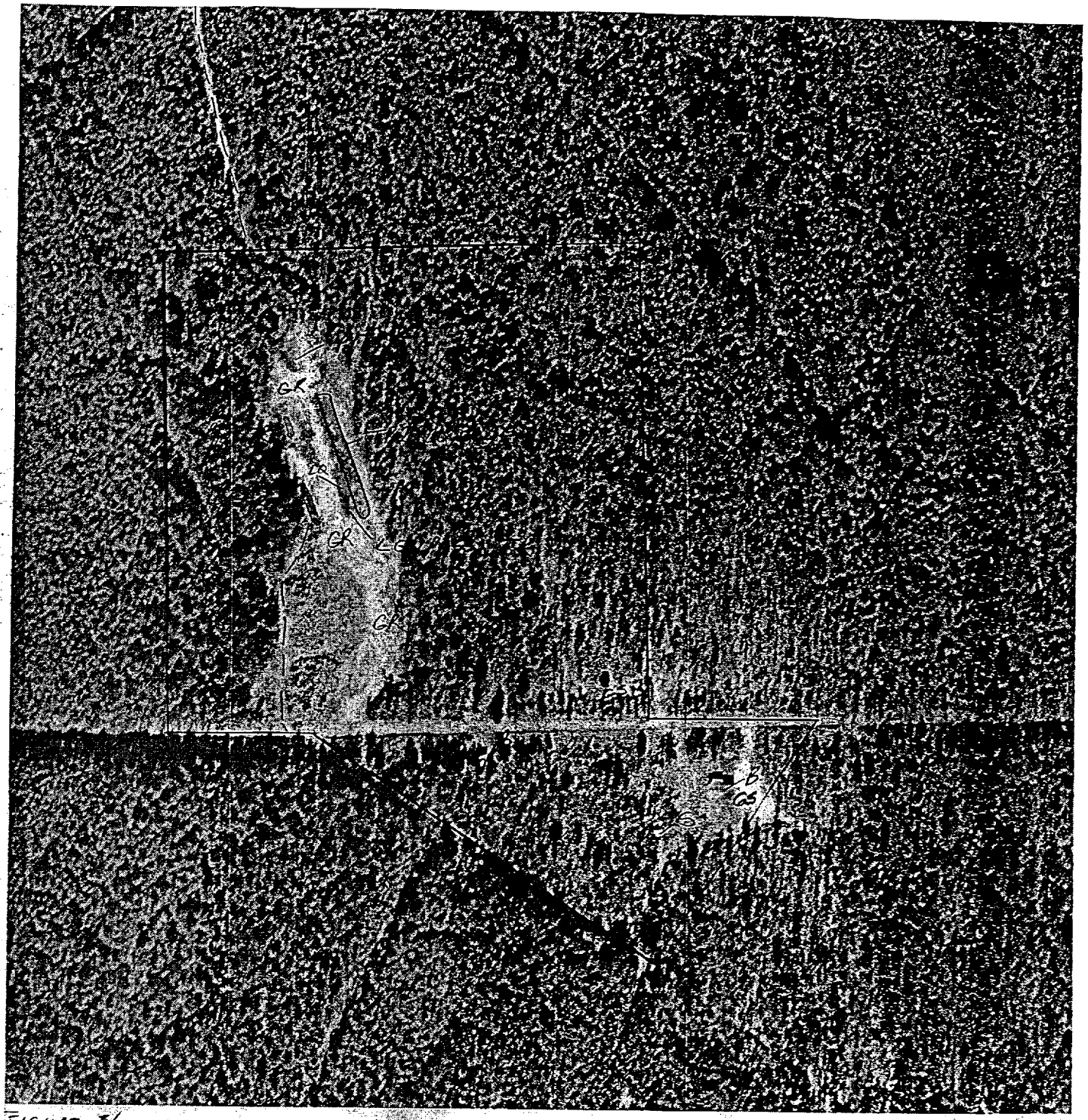


FIGURE 36
CAMP LEJEUNE STUDY AREA 74 NOVEMBER 29, 1984 APPRX SCALE 1: 2,300

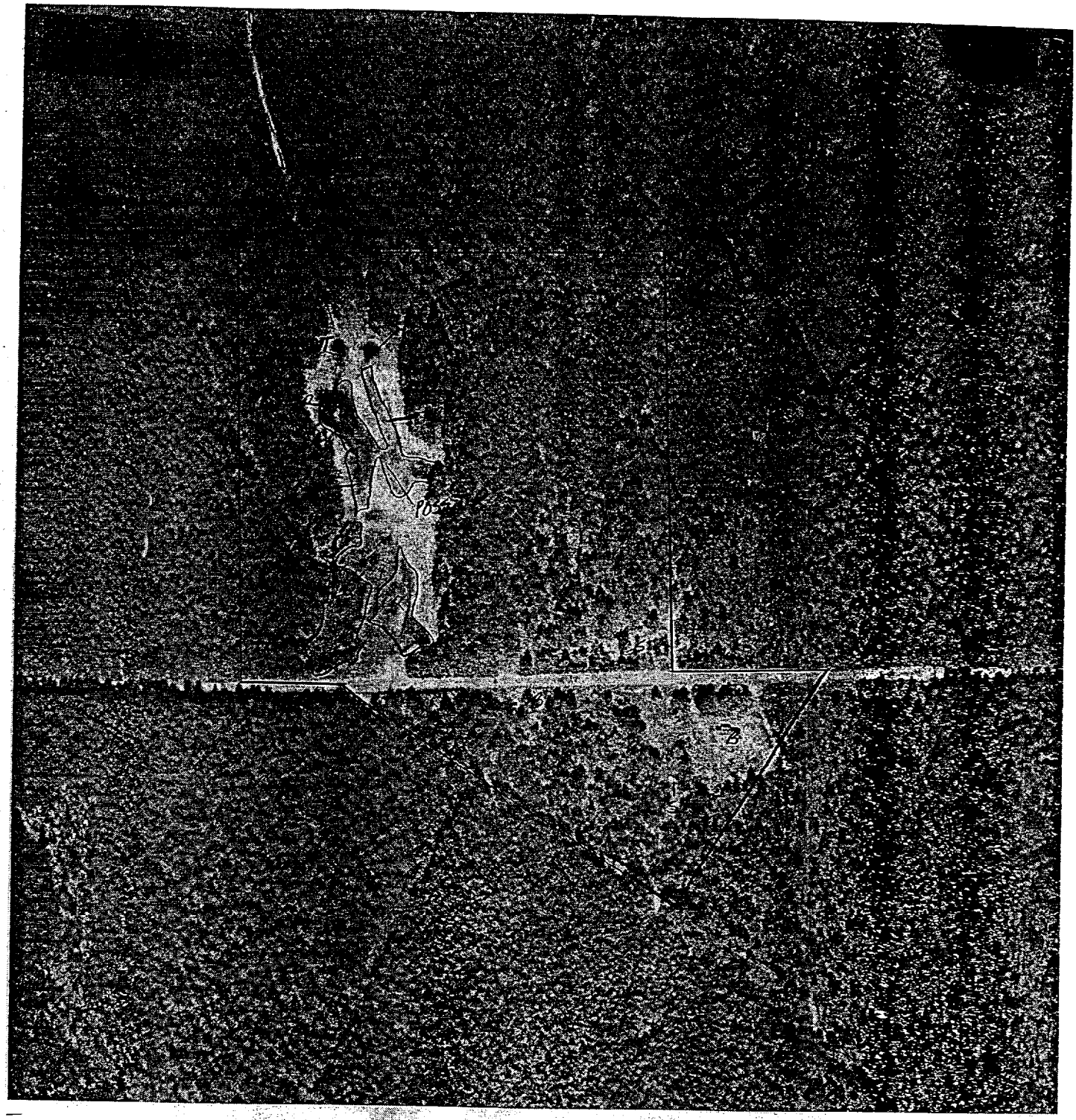


FIGURE 37 FEBRUARY 10, 1964 APPROX. SCALE 1: 2500
CAMP LE JEUNE STUDY AREA 74

FIGURE 36
CAMP LEJEUNE STUDY AREA 74 OCTOBER 4, 1970 APPROX SCALE 1: 23C